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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, JULY 7, 1877. NO. 1.

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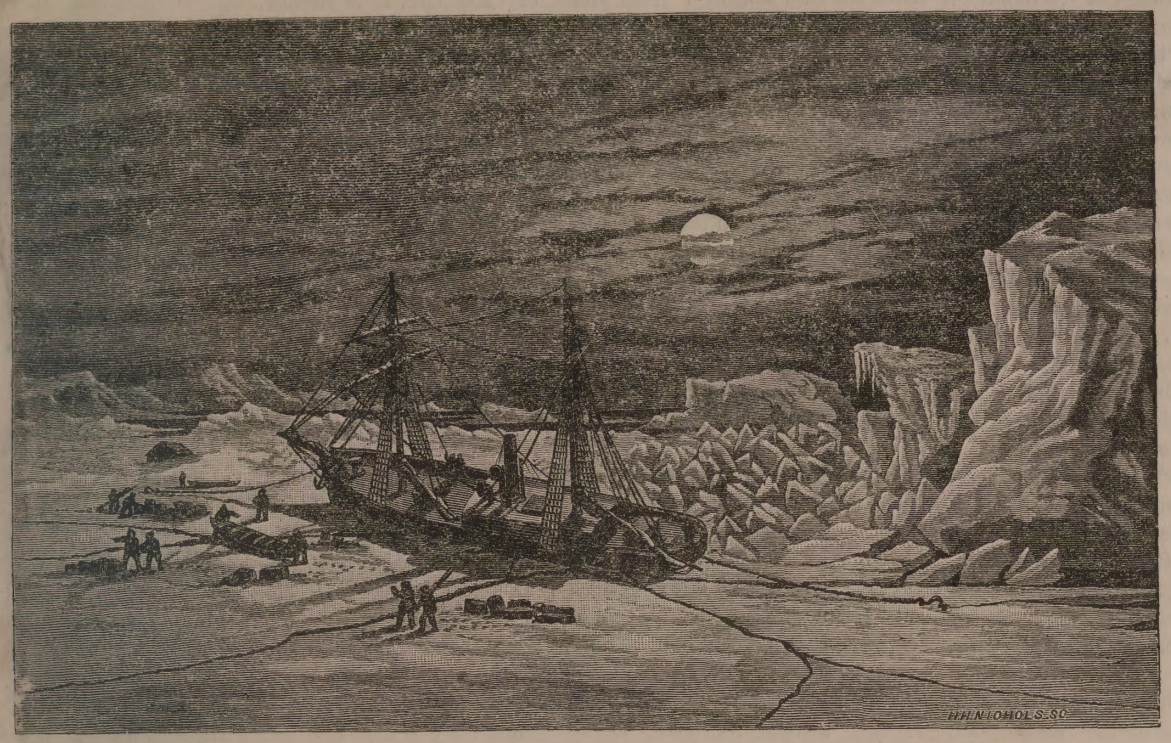

THE POLARIS EXPEDITION.

There has just been issued from the Government Printing Office, under the auspices of the U. S. Naval Observatory, a quarto volume of 696 pages, embellished with numerous illustrations, comprising the "Narrative of the North Polar Expedition of the U. S. S. Ship Polaris, Capt. Chas. Francis Hall, Commanding." The circumstances of this most extraordinary voyage, in which the navigators reached the elevated latitude of 82° 16′, the nearest to the pole that any vessel has reached under sail, the untimely death of the gallant Hall, and the frightful perils of the return voyage, which culminated in the drifting away of one part of the crew upon an ice floe, while the other part were forced to abandon the ship, reaching their country only after suffering the greatest hardships, and the final rescue of the floe party, are given in detail from the diaries of the participators, and render the volume one of absorbing interest.

Our illustrations comprise the rude monument erected above the remains of the ill-fated commander of the expedition, by the hands of the survivors, and that most fearful incident of this remarkable voyage—the accidental separation of the Polaris from a portion of her crew, during a terrific storm on the night of the 15th of October, 1872, when the ship was being crushed by the ice, and threatened with destruction at every instant, and the crew was engaged under orders of the officers in throwing provisions and stores on the ice, preparatory to abandoning the vessel and taking to the ice for safety.

The volume is appropriately closed with the Report of M. Malte Brun, Vice President of the Geographical Society of Paris, which awarded, at the general session April 21, 1875, the distinguished honor of the Roquette gold medal, to Capt. Hall, in recognition of his eminent services in the field of arctic exploration. We append in condensed form a few remarks from this Report that relate to the scientific results of the Polaris Expedition.

"The Prize Commission has before it several enterprises, which have had for their object either Smith's Sound, Eastern Greenland, Spitzbergen, or Nova Zembla. All of these deserve praise, but especially that of the Polaris, the ship in which the American Francis Hall passed beyond Smith's Sound and Kennedy Channel, as far as 82° 16′—that is to say, the nearest to the pole that any vessel has reached *under sail*—has particularly commanded the unanimous vote of the Commission."

"More than 700 miles of coast line have been discovered and reconnoitered. It is now proved that Kennedy's channel extends beyond Cape Constitution, the highest point reached by Kane in 1854. On the right, another strait (Robeson Channel) opens, having a very perceptible current from east to west. From the summit of an elevation near where the party wintered, the land was seen extending north to the 84th degree. The temperature was sensibly less severe than it was at a point several degrees further south, and animal life showed itself by the presence of numerous herds of the musk ox, with many hares and other animals."

"Dr. Bessels, the chief of the scientific corps to which the largest portion of these acquisitions is to be credited, established in Polaris Bay, 1871–1872, an observatory on an elevation 12m. above the level of the sea, and made a number of astronomical observations to determine its position, besides magnetic, meteorological, geological, botanical, zoological and pendulum observations."

"The flora and fauna of Hall Land—the name given to the prolongation of Grinnell Land and Washington Land towards the North—are very rich. Eight species of mammals, 23 of birds, 15 of insects, and 17 of plants, were found."

SULPHUR AND ITS USES.

By Prof. George A. König.

II.

II. Sulphates.—Immense quantities of sulphur form part of the geological structure of the earth's surface in the form of earthy sulphates. We have seen in last article how these sulphates give rise to the formation of sulphurets in veins, and how again they are produced by the oxydizing action of air and water upon the sulphurets, above water level. There is no valid reason against the assumption that this circuit of matter was ever different in its action; hence we should not use the term original when speaking of any combination of matter. We should ever bear in mind that every rock, every mineral, as we see it now, is but the product of the latest metamorphosis; we cannot say that the sulphurets are the original sulphur ores, nor that the sulphates are such. The *sulphate* of *calcium* is the most common of the latter. It is known as *gypsum* or *selenite* when crystallized with 21 per cent. of water, or *alabaster* when granular in structure, and *anhydrite* when it occurs without water. When artificially deprived of its water by heating, it is called *plaster*; the purest varieties, *plaster of Paris*. In the triassic formation this mineral forms large belts, ranges of hills many miles in extent, as for instance, on the south margin of the Harz Mountains in Germany. Such regions are remarkable for their barrenness and sterility.

Although gypsum may take the part of a fertilizer when brought upon other soils, in itself it does not possess the necessary elements of nutrition for vegetation in general. Gypsum is a very soft, white mineral, with a pearly lustre on cleavage faces. It contains in 100, sulphur 18.6, calcium 23.3, oxygen 37.2, water 20.9.

Barite or *heavyspar* is *sulphate of barium*, a white mineral, easily recognized by its high specific gravity, which is only inferior to that of the lead salts. Contains in 100, sulphur 13.7, barium 58.9, oxygen 27.4. This mineral is much rarer than the preceding one, and occurs chiefly in true veins, either alone or along with other minerals, especially sulphurets.

Cœlestite is *sulphate of strontium*, a white or bluish mineral, containing in 100, sulphur 17.4, strontium 47.8, oxygen 34.8. It occurs chiefly in thin beds, often together with gypsum, more rarely with barite. Its characteristic is the strong crimson color it imparts to a very hot flame. It forms the basis for the manufacture of the red light in pyrotechnics.

Kieserite is *sulphate of magnesium*, a mineral known only since the discovery of the immense salt deposits at Stassfurt in the Prussian province of Saxony. Here it occurs in the hanging wall of the rock-salt, together with the carnallite and other potash and magnesium minerals. It dissolves in water with difficulty, and is the principal raw material now used for the manufacture of Epsom salt, from which it differs only in the amount of water of crystallization. Kieserite contains in 100, sul-

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phur 20.5, magnesium 15.4, oxygen = 41, water 23.1. Epsom salt contains in 100, sulphur 14, magnesium 10.5, oxygen= 28, water 47.5.

Many attempts have been made to render available for industrial purposes these vast treasures of sulphur, but unsuccessfully. Reasons for these failures will appear in due course of this treatise.

III. NATIVE SULPHUR.—Occasionally, but far less frequently than the sulphates or sulphurets, we find native sulphur, that is, sulphur in its free or elementary state, in the rocks of various geological formations. It is usually intimately mixed with the earthy minerals of the rocks, especially with clays, marls, and limestones, more rarely with sandstones. Native sulphur possesses all properties of the artificial sulphur, which will be given later. The origin of these deposits is to be coupled with volcanic action, either still existing or extinct. If water be made to act upon metallic sulphurets at high temperature and under high pressure, an exchange of combination takes place between their elements. Chemical force and heat stand in a curious relation towards each other, as yet not fully understood. We know them in many cases to be converted one into the other, as indeed combustion, that is chemical combination of carbon and oxygen, is the general artificial source of heat; yet, in other instances, heat increases the chemical affinity of two elements, and decreases that same affinity of other elements. A striking illustration of this anomaly we have in the present instance. Sulphide of iron and water—as steam—at a high temperature, or as water, if the pressure be high enough, produce oxide of iron and sulphide of hydrogen; at ordinary temperature, oxide of iron and sulphide of hydrogen produce sulphide of iron and water. For our present purpose we have the volcanic heat—volcanos are always in the neighborhood of large bodies of water, the sea or inland lakes—and water permeating the rocks acting upon sulphuret deposits at great depths. The conditions for the reaction are complete, and a so-called sulphur spring—that is, water charged with sulphide of hydrogen, and often at a boiling heat—issues from the earth near or at a considerable distance from the volcano, according to the geological structure of the surrounding formations. Soaked up by loose, cavernous or porous strata of rock at the surface, the water comes in extended superficial contact with the atmospheric oxygen, which combines with the hydrogen of the sulphide of hydrogen, and the sulphur is precipitated in the solid form. Thus its intimate mixture and distribution in the beds may be understood. The craters of volcanos and large fissures in their sides are often filled with sulphur. Hernando Cortez, during the conquest of Mexico, drew his supply of sulphur for the manufacture of gunpowder from the crater of the great volcano Popocatepetl, at the risk of his life, and despite the superstitious fears of his men.

It is well known that the craters of active volcanos issue constantly gases and vapors, smelling of burnt sulphur. This is due to the presence in them of sulphur dioxide or sulphurous acid. Sulphide of hydrogen and the latter cannot exist together; they decompose at once into

$$\underset{\text{Sulphur dioxide}}{SO_2} + \underset{\text{[Sulphide of hydrogen]}_2}{(H_2S)_2} = \underset{\text{[Sulphur]}_3}{S_3} + \underset{\text{[Water.]}_2}{(H_2O)_2}$$

How the sulphide of hydrogen gets into the crater we have explained, and meeting there with sulphurous acid, decomposes into sulphur and water. Sulphur is volatilized by the great heat in the depths of the volcano, sublimes and condenses into crystals or crystalline crusts in the cooler parts of the crater and the fissures in the walls. The *Solfatara*, near Naples, illustrates the formation of native sulphur in all its modified forms. Sicily, where the volcano Ætna is the originator, has furnished the whole civilized world with this valuable and nearly indispensable substance, until within a recent time. Commercial monopoly, however, having raised the price of sulphur beyond a legitimate rate, the consumers have turned their eyes towards the other sulphur ores, especially the sulphurets, which encroach more and more upon the commercial importance of Sicilian or native sulphur.

[*To be continued*]

PARAFFIN --A SKETCH OF ITS HISTORY AND USES.

In the year 1830, the German chemist, Reichenbach, in the course of some researches upon the tar obtained from the red beech, discovered, in the residual portion of his distillate, a white translucent substance to which he gave the name of paraffin (from *parum* and *affinis*), in virtue of its great indifference to the action of chemical agents. For a long time it was looked upon simply as a chemical curiosity, but it was soon discovered that it could be obtained in quantity by the dry distillation of peat, lignite, boghead cannel, and bituminous shales; and the product at once became of commercial importance, because of numerous uses for which it was found to be admirably adapted. The development of the petroleum industry in the United States, likewise afforded another and very rich source of paraffin, so that at the present time its production amounts to thousands of tons annually.

The head-quarters of the paraffin industry, for many years, was in Scotland, where, under the superintendence of William Young, (the founder of the paraffin oil industry) several great establishments were erected for the production of paraffin oil and paraffin, by the distillation of the bituminous shales so abundant in that country. In this country enormous quantities of this material are produced in the operation of refining crude petroleum.

This operation is extremely simple. As most of our readers will be aware, the crude oil, as it comes from the wells, is subjected to a process of fractional distillation and purification, by which a number of products are obtained. The process may be briefly described as follows: The apparatus used for the purpose consists of an iron still provided with a worm of wrought iron pipe submerged in water for the purpose of keeping it cool. The still is filled with the crude oil, and the fire started beneath it. The first products to pass off are the very volatile liquids, rhigolene and chymogene, which can only be condensed by pressure or artificial cold. Then follow successively gasoline, naphtha and benzine. When the stream of oil indicates a gravity of from 65° to 59° (Beaumé) it is directed into the kerosene tank, and is allowed to continue until the gravity of the oil has reached about 38°, B. This portion of the distillate is the so-called kerosene or burning oil, and is subsequently purified by sulphuric acid and alkali. When this has run off the stream is directed into the paraffin oil tanks, where it is allowed to run until nothing but coke remains in the still. These products have a gravity of about 25°, B. From this distillate the paraffin is obtained by chilling, which causes it to separate in the form of crystalline flakes. It is then folded in cloths and subjected to hydraulic pressure, to squeeze out the oil. The resulting yellowish wax is purified by repeatedly melting it in naphtha, chilling and pressing.

Pure paraffin is a white, wax-like substance, without either smell or taste, slightly greasy to the touch, with an average specific gravity of 0·877, and harder than tallow but softer than wax. Its melting point varies somewhat, according to the source from which it is obtained, but for that obtained from petroleum it is 109·4° (Fahr.), while for that obtained from shale, or ozokerite, it is higher. Its composition also varies slightly, according to its source, but it may be given as carbon 85·26, hydrogen 14·74 per cent. From numerous investigations into the composition of paraffin, it has been inferred that it is a mixture of several homologous hydrocarbons of the marsh-gas series. It is insoluble in water, but dissolves in alcohol (sparingly), ether, turpentine, oil, olive oil, benzol, naphtha, chloroform, carbon disulphide and aniline. Its boiling point is about 575° Fahr., and it may be distilled without decomposition.

At ordinary temperatures, it is unaffected by either acids or alkalies, or chlorine, but when submitted for a length of time to the action of chlorine or bromine, chlorinated or brominated compounds are formed, with disengagement of hydrochloric or hydrobromic acids.

When heated with sulphur at a moderately high temperature, it is decomposed, carbon separates, and sulphuretted hydrogen is evolved copiously and steadily. When melted and cooled very gradually, and subjected at the same time to slight but steady pressure, it becomes quite transparent, like ice, but a blow, or even a scratch, will alter its molecular structure and cause it to resume its normal white and translucent appearance.

The most important application of paraffin in the arts is in the manufacture of candles, for which its pure white color, its freedom from offensive odor during combustion, and the remarkable purity of its light, render it peculiarly well adapted.

Its eminent water-repellant properties have caused it to be used, and with great success, for water-proofing fabrics of wearing apparel, military equipments, such as tent cloths and the like. By reason of this same property it is very generally applied for lining casks and other vessels of wood, to keep them sweet and to prevent the absorption of their contents by the wood.

Beer barrels, wine casks, and the like, are largely treated in this way, and with the best results, since the material not only completely seals their contents, but effectually preserves them against fouling. It has been suggested for the preservation of timber, but has not, we believe, been much used for this purpose, owing to the great difficulty of securing perfect penetration; but the bungs of beer barrels, wine casks, etc., have been saturated with it with great advantage.

Being indifferent to nearly all chemical reagents, it is much used by the chemical manufacturer, and in the laboratory for lining tanks and other vessels of wood in which chemical operations are carried on with impunity, that would otherwise prove destructive to the vessel. In the gun cotton manufacture, for example, wooden tanks lined in this way are used for holding the bath of concentrated nitric and sulphuric acids, with which the conversion of the cotton is effected; and wooden boxes similarly coated are often used to hold the exciting fluid of galvanic batteries.

The same water-repellant property is utilized in the common practice of the manufacturer in saturating the corks, or sealing the space about the stoppers of glasses, and jars containing chemical compounds susceptible of alteration by the entrance of air or moisture, the thin film of paraffin thus applied, constituting a perfect seal.

Dissolved in naphtha, it will be found excellent for preventing the scaling and crumbling of brick walls, stone work, etc., when they are exposed to the action of the weather, and for the protection of fine wood work under similar circumstances. The preparation of water-proofed paper by using paraffin in place of wax, is very common.

Plaster casts, images, statues, and other art objects of gypsum, which, when exposed in the air, soon become defaced by dirt and dust, and lose their beauty, may with great advantage be saturated with paraffin, which not only renders the material harder to resist wear and improves its appearance, but permits of the objects being washed when they have become soiled or defaced.

Paraffin is one of the best, if not the best, non-conductor of electricity, and has been for years in very successful use for the preparation of telegraphic insulators, for which it is vastly superior to glass. It has also been suggested for insulating the conductors in the construction of lines of underground telegraph, for which its eminently neutral properties render it much superior to tar, etc., commonly used.

It has found use in surgery, as a covering for splints in the setting of fractured or broken limbs. It is now almost universally used in the place of sulphur in the preparation of matches, for which purpose it is much superior, not only avoiding the intolerable smell of the latter, but lessening the danger of accident by fires, by the ease with which it is extinguished when the stick is thrown away, but also effectually water-proofing the tips.

Applied upon the flat-iron in the laundry, paraffin imparts a beautiful gloss to starched goods, greatly lightening the labor of ironing and leaving no stains upon the fabric.

It is used also to prevent the violent foaming attending the evaporation of the sugar cane juices in the vacuum pans. It has been suggested, and doubtless practised, for preserving meat, by shutting out all access of the air, and for a variety of miscellaneous uses of lesser note. Altogether it must be regarded as one of the most useful of chemical products, and when its present enormous production and consumption is contrasted with the fact that thirty-five or forty years ago it was a comparatively rare substance, even in the chemical lecture room, it furnishes a brilliant example of modern industrial progress.

W.

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

With the present issue, THE POLYTECHNIC REVIEW enters upon its FOURTH VOLUME. In looking back upon our first prospectus, in which in troublous times we dedicated the new publication to SCIENCE AS APPLIED TO THE USEFUL ARTS, before we launched the intended monthly upon the sea of journalism, we have no reason to be ashamed of our performances as compared with our promises and agreements. The monthly has developed into a weekly, and that weekly been enlarged and improved without increase of subscription price. No entangling alliances have biased or hampered the free expression of our opinions. Anonymous editorials and descriptive articles have never appeared in our columns. We have been strictly scrupulous about giving full due and explicit credit when reproducing articles from the columns of our contemporaries. Advertisements have been confined to the cover pages, and puffs, controversies, and trivialities excluded from the entire journal. The circulation has increased rapidly and steadily, and has been pushed principally among prominent manufacturing establishments; so that now we may say that to the best of our knowledge, 75 per cent of our circulation is among heads of firms.

During the first two volumes we were content with the deserved appellation of the "most reliable technical journal in America." We now desire to add for ourselves that we have the SECOND LARGEST CIRCULATION of any technical paper in the country. While on the one hand we have no entangling alliances to cause unjust discrimination, on the other, we have sufficient pecuniary interest and personal pride in the journal which bears our names, to guarantee the public against anonymous and irresponsible management.

Not only our subscription lists, but our order books, are open for the inspection of advertisers who may wish to assure themselves of the extent, nature, and direction of our large circulation, and of our fairness of dealing and uniformity of charges and terms.

As heretofore, we shall continue to devote our best energies to the growth of the subscription department, and feel sufficiently encouraged by our past experience, to entertain the belief that, with the gradual advent of better times, the "REVIEW" will have found its way as a welcome visitor in every manufactory of importance in the land.

THE EDITORS.

"GAVALRY BOOTS."

Slight in material and workmanship is, in these days of paper-soled shoes, lead-covered "tin plate," and other shams and slights—so common and so productive of loss and annoyance, that it is well worth our frequent consideration whether it would not be worth while to go back to the old slow days when things were built to last, and the use of poor or insufficient material and careless workmanship was considered a crime and a disgrace. Now-a-days (we quote from one of the most eminent of American iron bridge builders) a county bridge is considered a good bridge if it will stand until paid for. Trusses that shut up in the middle like a jack-knife; court-houses that break down by their own weight, and post-offices that drop domes down on their occupants; crank-shafts that twist off because a gale happens to come up; new iron vessels that break in the middle on their first trip; roofs that leak, and sewers that cave in, because of "that heavy rain;" pavements that wear out by being trodden on, and bridges that have to be walked over to keep from being shaken down—these are getting too common and too disgraceful. There is a story about a man who bought a pair of new boots from a Chatham Street dealer, and had the soles gap open the first week. Showing them to the dealer, his indignation was met by an equally indignant and surprised "Mein Gott! man! Vat you pin doin' mit dem boots? Vy, you musht pin a *valkin* in dem boots; *dem ish gavalry boots!*"

It is sad to think of, but so few of our modern buildings, machines, fabrics or products will bear inspection and use, that the expression involuntarily rises to the lips of one who has once heard the story, "dem's Gavalry Boots." G.

IMPROVED WIDE LEATHER BELTING.

The great advantages of the transmission of power by belts are the smoothness and freedom from noise and vibration, and the extreme simplicity of the devices employed. The use of flat belts in such large excess over those of any other form is owing partly to the superior convenience of the form of pulley which they require.

In this country the use of wide belts to convey motion from the first moving power (instead of shafts and gearing, as abroad) is a peculiarity which has greatly developed the manufacture and extended the uses of very wide belts.

To retain flat belts upon the pulleys, it is advantageous to give the face of the pulley a certain amount of "crown" or swell in the centre. The reasons for giving this convexity, and for its action, are not generally thought of, and it may be interesting to note them here.

To shift a running belt from one part to another of a cylindrical drum or flat-faced pulley, it is only necessary to press the advancing or on-running side of the belt in the direction of the required change. Crowding the retiring or off-running side produces no effect whatever.

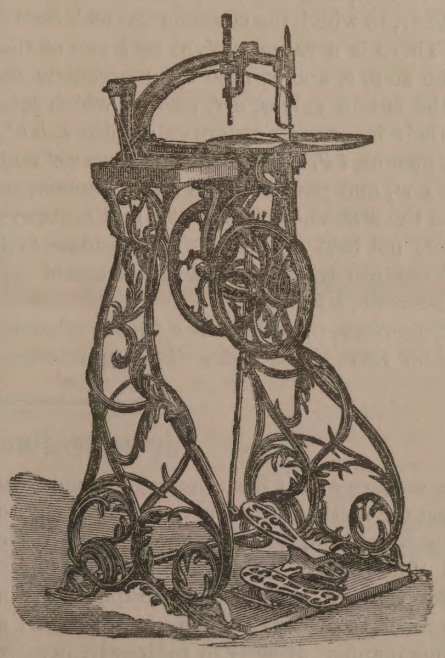
An elastic flat belt running on a revolving sphere or cone will advance gradually towards the greatest diameter—that is, towards the largest instead of the smallest end of the cone, and towards the highest convexity of the sphere, instead of running off at one side, as might at first be supposed. This is because the bearing edge of the belt (that towards the greatest diameter) will be kept in greater tension; the outer edge (towards the least diameter) will be bent downward, and the effect of this is to twist the advancing or on-running side of the belt towards the greatest diameter, with the result of causing the whole belt to "climb" towards the highest portion of the pulley. If, then, the pulley be given central convexity or swell, any tendency to crowd the belt sideways will be resisted by the climbing tendency, and the belt will be kept central.

As most wide leather belts are made, the back portion of the hide (which portion has the closest-fibred and hardest leather) is in the central line of the belt, and consequently receives the greatest strain and wear, while the looser-textured material lies along the edges of the belt, where, too, the tendency is to stretch more than the centre, by reason of having less lateral support. It is in the centre or back portion of the hide, too, that the full or humpy places of hard and stubborn material are found, and these it is difficult to work flat in the whole hide. Such parts hence tend to reduce the bearing surface of the already diminished effective width. An improvement in the manufacture of wide double-leather belts, designed to obviate these difficulties, has been introduced by Messrs. Alexander Bros. of this city, and consists in cutting the hides along the middle or back line, and turning the edges of this back cut outwards, and the edges of the side cuts inwards, in making up. The consequences of such mode of manufacture should be to bring the more yielding portion of the leather over the centre of the pulley face, permitting a stretching of the belt to fit this crowning surface, and enabling the firmer edge portions to bed themselves down to the edges of the pulley, thus increasing the effective width of the bearing surface, and lessening the amount of slip; the workman having, too, been enabled to work down the uneven or full places along the back line of the hide.

We illustrated by sectional cuts this mode of belt making in our issue of June 20th, 1876. G.

THE FLEETWOOD SCROLL SAW.

So popular has scroll sawing of late become, that there has sprung up an almost endless competition among manufacturers to furnish the market with a machine that shall combine simplicity and strength with cheapness and grace of outline; for the use of the scroll saw is not only widely diffused throughout the industrial pursuits, but has entered the household, where it not only affords pastime and amusement, but tends to develope in the young artisan such ideas of symmetry and design that cannot be other than beneficial to him when in after years he enters the army of workmen that fills the world with so much that is beautiful and useful.



The saw which we herewith illustrate is that made by Messrs. Trump Bros., of Wilmington, Del. Its mechanism consists of a driving wheel worked by means of a treadle, and supplying motion by frictional attachment to the fly-wheel shown in the fore part of the figure. The saw is spanned vertically between two spindles attached to the cast iron frame of the machine, and has tension given it by two springs, one above and the other below the working table. The motion of the saw is produced by means of a connecting rod working from the plate on the axle of the fly-wheel; it is this plate that is in contact with the driving wheel proper. The boring and drilling attachment shown in the figure permits of holes being rapidly and smoothly cut without stopping the action of the machine. O. C. W.

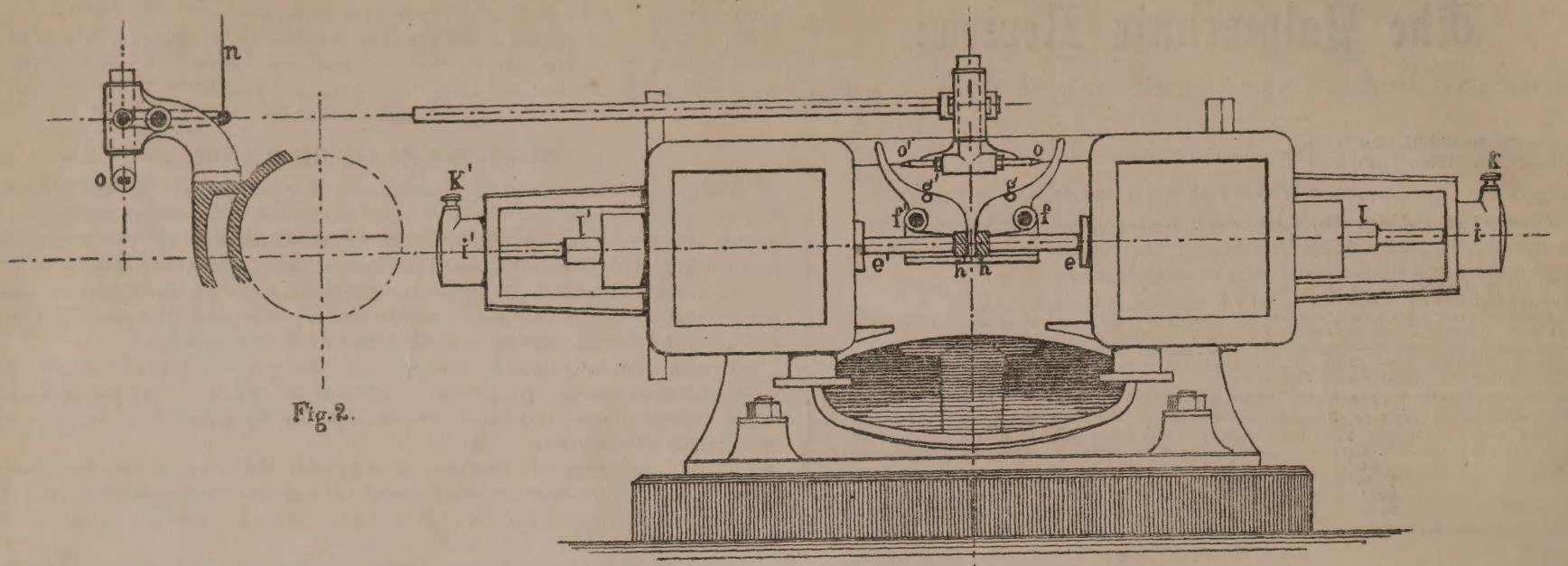


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Fig. 1.

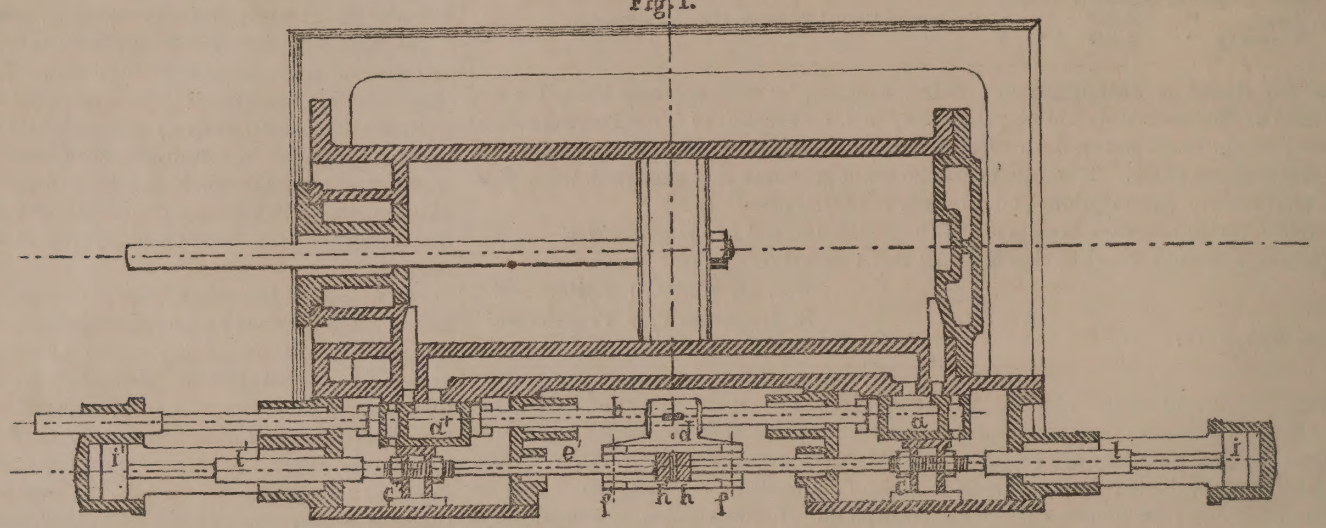


Fig. 3.

WANNIECK & KOEPPNER'S AUTOMATIC CUT-OFF GEAR.

The effect resulting from connecting the governor to the cut-off gear, and the application of this principle to the Corliss engine, has already been fully described in No. 7, vol. iii, of the POLYTECHNIC REVIEW.

The main objections to the Corliss valve motion are, the complication of its gear and the disturbance resulting from the unequal wear of its circular valves and faces. It is easily understood that any wear reduces the diameter of the valves, while the radius of the seats is enlarged. Whether these objections are of any importance depends very much on the circumstances of each special case. Good design and workmanship, as well as careful and intelligent attendants, may materially reduce the damage caused by these defects, but still they do exist. The common flat slide-valve is not open to these objections, and, the motion being straight, its gear is simple, not needing so many movable joints as the Corliss arrangement.

Fig. 1 is a side elevation, Fig. 2 a cross section, and Fig. 3 a plan and section of Wannieck & Köppner's Automatic Cut-off Gear, in which the common flat slide-valve is used, having a cut-off plate on its back. There is a valve, *a a'*, at each end of the cylinder; they are connected together by the stem *b*, and worked by an eccentric, as usual. On the back of the valves *a a'* are the cut-off valves, *c c'*, each of which acts independently. Their stems, *e e'*, carry on their inner ends square catch-pieces, *h h'*, while on their outer ends they are fitted with pistons, *i i'*. Between the valves *c c'* and the pistons *i, i'*, the stems are thickened at *e e'*, and pass through a stuffing-box, so that the steam in the valve-chest, pressing on the difference of area of *e* and *l*, always forces the cut-off valves outwards, if they are not held otherwise. To regulate and arrest their movement, the pistons *i i'* are fitted into cylinders, and the escape of the air before the pistons can be regulated by set-screws, *k k'*.

The valve-stem *b* has keyed onto it a cross-piece, *d*, which has a groove wherein the two square catch-pieces, *h h'*, of the cut-off valve-stems slide. This same cross-piece also has two pins, *f f'*, forming the fulcrum for two pawls, *g g'*, which by their own weight always tend to fall into the position shown in Fig. 1. Their lower ends are notched, so as to fit, in a certain position, the square catch-pieces, *h h'*, of the cut-off valve-stems.

The governor, through the rod *n*, shaft and levers, works a vertical bar, sliding in a bracket which is bolted to the cylinder (see Fig. 2). This sliding bar has at its lower end a cross-piece, into which are inserted steel bars, *o o'*; these are situated between the curved upper ends of the pawls *g g'*, and the latter, when moved to and fro, will touch the bars *o o'* at some point of their travel, are thus disengaged from the square heads *h* or *h'* of the cut-off stems, and the cut-off valve *c*, driven outward by the pressure on the enlargement *l* of its stem, will close the steam-port in the main valve *a*. When the cross-piece *o o'* is lowered, the pawls *g g'* will be disengaged earlier, while when *o o'* is lifted, the disengagement of *g* or *g'* will take place later in the stroke, and the point of cut-off must naturally correspond to the disengagements. When the main valve-stem *b*, carrying with it the cross-piece *d* and the pawls *g g'*, comes to the extreme end of its travel, the pawl *g* situated at that same end again engages with the square head *h* on the corresponding cut-off valve-stem *e*, carrying it along and keeping the steam-port open, until pawl *g* and cross-piece *o* come into contact, when the cut-off stem becomes disengaged and steam is again cut off. To prevent misunderstanding, it may be mentioned that the position shown in Fig. 1, where both pawls are engaged with the cut-off valve-stems, never occurs when in action; one of the cut-off valves is disengaged while the other is engaged, and *vice versa*. Experience with engines to which this gear was fitted has shown that it is quite as sensitive and effective as the Corliss valve-motion, while on account of its greater simplicity it gives less wear and tear, requires less careful attention, making it better adapted for isolated localities where skilled attendants cannot be had.

J. HAUG, M. E.

THE INCREASING USES OF STEEL.

Although steel-making is by no means a modern art, it has remained for our own times to so greatly improve upon and cheapen the method of its manufacture, and to have so recognized and applied its admirable adaptation for innumerable uses in the arts, that ours has been not inaptly called "the age of steel." For an indefinite period steel was used almost exclusively for the implements and paraphernalia of warfare, while to-day it is not affirming too much to declare that there is scarcely a manufactured product which does not in some manner, directly or indirectly, involve its use. So material have been the improvements in the art of steel-making, with regard to rapidity of production, cheapness, variety, and excellence of product, that have of late been introduced, that the metal has in many important uses practically taken the place of iron. Steel castings, for example, now take the place, to a considerable extent, of expensive iron forgings and castings, which latter are not only costly from the large amount of material used in their construction, but from the great amount of labor required of the machinist to fit them up, and which, after all, are often so clumsy in appearance as to reflect but little credit upon the maker. The substitution of steel for these purposes has happily changed all this. A small amount of finish only is required, even less than for cast iron, a fact which notably lessens the work of the machinist; it is easy to work, because of its homogeneity; it is readily forged and bent (and this is especially true of crucible steel); and when the castings are light, they may be hardened and tempered almost as readily as tool steel. It is used with advantage and satisfaction for carriage hardware, steam fittings, parts of steam engines, wrenches, and general machinery, being cheaper than forgings, and true to pattern.

The introduction of the Bessemer steel manufacture, a modern innovation, the

details of which must be well known to all our readers, has contributed enormously to the consumption of steel, from its great capacity for production, cheapness, and adaptability for numerous uses. Bessemer steel is very mild, but homogeneous and tough. It has thus far been used mainly for rails to substitute much heavier ones of iron, for which it has fully demonstrated itself to be superior both in wear and liability from lamination. The uses of Bessemer metal, too, are gradually extending to other applications, and its production, especially in the United States, is increasing rapidly.

Another process for making steel direct from cast iron—the Siemens-Martin process, with the open hearth—though of even more modern date than the Bessemer, has already taken on the proportions of a great industry, the metal being employed largely for the tires of locomotive driving-wheels, frogs, switches, crossings, besides a number of miscellaneous uses for railroads and shops. Even the higher grades of steel are successfully made by this process.

An ingenious process for combining iron and steel, and which promises to become of considerable importance, deserves mention in connection with our subject; the process designs to effect the combination of the two materials in any desired proportion, in merchant bar or plate, or in any special forms that may be required. The materials employed are puddled or scrap steel of any description and common plate iron, and no apparatus is required that cannot be found in every rolling-mill. The steel is worked precisely like wrought iron, the scrap being placed in a close box of plate iron, which, surrounding it on all sides, protects it fromburning while being heated to the welding heat. This combination metal is made to vary considerably, according to the uses to which it is to be put. Some bars, for example, are made with an iron core surrounded by a tube of steel, which in turn is surrounded by its protecting shell of iron, all thorough welded. This outer covering is about enough for the average finish, so that when required it can be removed to expose the steel for wearing surface. It is designed to make rails by this process, the tread being of steel of a higher grade than can be used for this purpose, having the thin iron covering, which shall extend down to the web, when the thickness will increase until it joins the foot in which the steel shall terminate in the form of a wedge, leaving a foot of solid iron.

It is claimed for this combination that, in comparison with iron or steel used separately, it possesses higher qualities than either alone; that it can be used successfully when subject to great strain or jar, because it has the toughness of the iron on the surface or in the centre, or both, combined with the greater strength of the steel. Furthermore, the iron, being fibrous, is not liable to fracture; while with steel, being homogeneous, a small flaw on the surface will be communicated through the whole section. But when the steel is covered by or covers a body of iron, to which it lends its great stiffness and strength, while the iron, on the other hand, gives to the steel the requisite toughness and resistance to rupture, a combination is effected that possesses virtues which neither element has in itself. It is affirmed that strap and band iron, as well as cotton ties, might be made by this process, well annealed so as to be easily punched and bent, and which could be smaller and lighter than iron for the same strength; and furthermore, that the combination could be applied to hardened steel safe plates, in which the iron would act to prevent the steel from being brittle. Such plates should offer resistance to the most violent blow, as well as to the drill of the burglar. Armor plates also, made in this way, appear as though they would be very efficient. The steel, in combination with iron, being very elastic and strong, might resist a force that would penetrate solid iron, which has but little elasticity and offers a dead resistance.

A great improvement in steam boilers, recently effected, consists in making fire-boxes, crown-sheets, and all heating surface of steel, while some makers construct their work entirely of this material. From the superior conducting qualities of steel as compared with iron, and its greater tensile strength, which permits of the use of a thinner shell, and consequently a more rapid and economical transmission of heat, boilers so constructed should possess decided advantages to offset their increased cost.

A considerable change is demonstrated in the working of steel in the fire, since chrome steel has come into use: it can be brought, it is asserted, to a welding heat without in the least injuring its properties. Care should be taken, however, that in hardening the steel does not exceed a low red, or injury will ensue similar to that of burning carbon steel.

It can be used for punches in working iron that is thicker than the diameter of the hole punched. This, till lately, was considered impracticable, except in punching nuts in which the difference is very slight between the length and diameter of the hole. We are told, on competent authority, of the punching of hardened steel safe-plates with tools made from this steel.

A large portion of the St. Louis bridge and the temporary or working cables of the great East River bridge were constructed from this material. It is also used very extensively and successfully for rock drills and for all classes of tools required to resist heavy strains.

In general terms, it may be said, finally, that for all uses where stiffness, lightness, strength, and wear are demanded, steel is gradually usurping the place of iron; and of the numberless examples of this fact that might be offered, we need only mention its use for shafts and pistons, in the form of wire rope, for bridges, transmitting power, &c.; for guns and projectiles, armor for vessels, in the form of springs for motors, the great demand for which has largely increased their qualities, &c.

The growing importance of our steel industries is, finally, the best evidence that the value of steel in the useful arts is rapidly becoming generally recognized—a fact which the extraordinary increase of production during the past few years of unparallelled commercial depression has not sufficed to modify, viz.:

We here give the figures of Bessemer steel production in net tons during the past three years ending with December, 1876.

Details of Production.	1874.	1875.	1876.
Pig and spiegel converted	204,352	395,956	539,474
Ingots produced	191,933	375,517	525,996
Rails produced	144,944	290,863	412,461

The figures of production for 1876 show, therefore, an increase in this branch of metallurgical industry of about 30 per cent. over those of 1875, and of about 250 per cent. over those of 1874, and this, too, while the pig-iron industry of the country was decreasing at a rate that, if continued, would utterly extinguish it in a decade; nor did we import during 1876 a single ton of steel rail. The production of Siemens-Martin steel showed also a gratifying activity during 1876, increasing from a production of 9050 tons in 1875 to 21,490 in 1876, or about 125 per cent.

Of other forms of steel than the above-named, we produced in 1876 about 50,000 tons, nearly the same as in 1875. B. P. T.

THE PRODUCTION OF GEAR WHEELS.

For the transmission of power with constant directional relation and absolutely constant velocity ratio, we employ to best advantage, toothed wheels, the general principle of action being by rolling contact (as in friction wheels), but having a certainty of action and freedom from slip (and its consequent loss of *absolute* velocity ratio) given by the sliding contact of the individual teeth. Friction-wheels act by the mutual interlocking or gearing of the minute roughness upon their surface; but in order to produce sufficient engagement to prevent any slip, it would be necessary to press them together with a force that would eventually break down or destroy these roughnesses and would also produce too much side-pressure upon the journals. By magnifying these minute roughnesses into teeth, and so proportioning their size as to ensure absolute mutual presentation or gearing, slip is effectually prevented; but unless, while thus magnifying the teeth, we so shape them as to permit of easy sliding contact without any *butting* friction, we will find that the certainty of action that we aimed at securing, has been obtained—as in the case where we pressed the friction wheels too firmly together—at the expense of stress and friction; but in this case this stress and friction are transferred to the individual teeth instead of the journals. It is requisite, then, in laying out the teeth of gear-wheels, that we shall secure absolute uniformity of size and spacing, and such form as shall give us no friction but that due to the sliding of two tangential and curved surfaces. In order to reduce this last to the minimum, such materials must be chosen as shall have but a small coëfficient of friction; and the finish of the surfaces must be as accurate as practicable; while to maintain the uniformity of spacing, and the proper outlines, the material must also be homogeneous, and possess a high tensile strength and resistance to abrasion.

The problem in laying out the teeth of gear wheels, is to find such curves therefor as shall, when fixed to the pitch-circles, so move each other by sliding contact, as to exactly replace the rolling action of the pitch-circles. If we have any convenient curve for the edge of one revolving piece, the curve of the other piece will drive it (or be driven) by sliding contact, and will keep the velocity ratio constant, if the common tangent to the two curves divide the line of centres at a fixed point in all positions of contact.

There is a fearful amount of learned obscurity and high-flown muddiment in nearly all of the treatises on gearing, which are calculated to make a very simple matter appear quite complicated, and are entirely beyond the comprehension of ninety-nine out of every hundred men who need to understand them, and who wish to understand them, but from whom they are removed as certainly as though in Arabic or hieroglyphics. About the whole amount of it is this: that any two gear-wheels (circular or non-circular) can be made to gear correctly, if upon the outside of one and the inside of the other pitch line, any curve at all (circular or non-circular), be rolled in the same direction, to give a face and a flank; the next pair of faces and flanks may be made with the same or with any other describing curve. The other halves of the teeth, or the curves for the other sides of the pitch lines into which these curves are to be extended for completing the teeth, are made by rolling describing curves similarly upon the other sides of the pitch-lines.* Still, the matter has appeared so complicated that a large proportion of gearing is laid out by rule of thumb—with correspondingly unsatisfactory results. The introduction of the Template Odontograph of Willis, with its important modification by Robinson,† enabled the pattern-maker and gear-cutter to abandon the "rule of thumb," and use strong and smooth-running curves for each individual tooth, with economy of material; but in building up a pattern he has, no matter how careful he be, another difficulty to contend against—the question of spacing or dividing—as the slightest displacement of a tooth is a detriment. Furthermore, a certain amount of draft must be given the pattern, and, let the ramming be never so hard and equable, and the drawing be never so careful, the casting will not be perfect as a casting, and the wheel will not be perfect as a gear-wheel. If the castings are left rough there is more or less jamming and unnecessary friction; if the teeth be cleared with a cutter, they will wear unequally; and if their whole working surfaces be cut, a great expense has been undergone, to cut away the hard skin of the casting and expose the softer metal!

The skin of a sand-casting has usually a coat or film of silicate of the protoxide of iron (really a species of glass or enamel), produced by the action of the sand of the mould on the iron. This enamel is a great protection against rusting. Cut gears, or those in which the skin is worked off, have no such protection.

Now, here are the troubles in gear-wheel making. Let a pattern-maker be as careful and conscientious as he can be, he will not cut the 96th tooth for a pattern as accurately as the first, nor just like the 48th; and no compasses ever yet divided a circle with absolute accuracy, unless more time was spent on the job than men can afford in these days. Again, no glue and nails and guess work can be relied upon to plant and hold the teeth accurately on the rim. Further, no moulder can make an absolutely good casting from such a pattern, or from any pattern got up in that way—and this entails expensive gear cutting as a remedy—not without producing faults of its own.

* To Prof. S. W. Robinson, of the Illinois Industrial University, and a valued contributor to THE POLYTECHNIC REVIEW, practical men are much indebted for filtering much of the mud out of the many solutions of the gearing problem. His elaborate but clear discussions of the subject appear in *Van Nostrand's Engineering Magazine* for July, 1876, and extended in Van Nostrand's *Science Series*, No. 24.

† See illustrated article on "A New 'Short Cut' Method for Describing Gear Teeth," in THE POLYTECHNIC REVIEW, ii, 99—date of Sept. 30, 1876.

As to the question of delay and cost in getting up gear-wheel patterns, it is well worth considering, especially when perhaps but one wheel is to be made from each pattern, and work is contracted for delivery under forfeit, at an early date. Where the pattern is kept for subsequent castings, it is expensive and dangerous to store; and a good fire in a pattern shop will practically put a firm out of business for a year or so.

Now to digress (apparently) for a few minutes. What would any of our readers think of a man who, when casting a spur-fly-wheel in eight *fac-simile* sections, should make eight separate patterns, all intended to be exactly alike, to cast these eight sections? It seems absurd to even suppose such a case; but a still more wasteful practice prevails in nine out of ten of our foundries! The absurdity and waste is carried still further by making a separate pattern for each tooth, even if there be 256! Not that there is not a better way, for there is an excellent and well-tried system, by which a tooth pattern may be cut out in hard wood, put on a radius-bar and tested to absolute accuracy with its opposing tooth; and three or four of these teeth, joined together and properly mounted on an index-wheel or dividing wheel in a moulding pit, will produce a better mould and a cleaner casting than the best pattern work and moulding can attain to; the skin may be left on, very little dressing is required, and the expense of making and storing the pattern is done away with.

It should be said that the experience of one of our most prominent and long established firms of founders and machinists (Messrs. Poole & Hunt, of Baltimore, Md., who deserve great credit for their introduction of the machine-moulding system, at a very heavy expense for plant) is that the system must be kept in *constant use* in order to produce good work at moderate profit. It has been more with the view of calling attention to the superior quality of machine-moulded gears, than to recommend the adoption of moulding machines by small establishments, that the present article has been penned.

G.

BRICKS AND BRICK MAKING—XIX.

THE MANUFACTURE OF PRESS OR FRONT BRICKS.

The following article refers chiefly to Philadelphia practice with hand presses; and for many of the facts therein, as well as for the revision of the whole, the writer is indebted to Messrs. F. L. & D. R. Carnell, of this city:

In the first place it is necessary to have a clay that will burn a good and even color, and also to have a loamy sand that is capable of being screened through a sieve of 30 to 40 meshes to the inch, and also that will burn a good color. After having the above, the clay is thoroughly tempered (it was formerly tempered for this purpose by hand with a spade, but it is now tempered with an ordinary tempering wheel), free from coal dust which is sometimes mixed among the clay for common bricks. It is then moulded by a good moulder. It requires one of the best skilled hands for these bricks, as it is necessary for them to be moulded without marks or "sand flaws," as these will show after the bricks are burned (sand flaws are where the roll of clay has been rolled in sand, as is necessary, and two sanded parts are allowed to come together, in which case they will not adhere, but the faults are not perceptible until after burning, when they can be seen very plainly). The bricks are moulded under a shed; the boards on the roof are left loose, so that in good weather every other board may be removed and placed on the adjoining board, thus leaving the sun and air to penetrate into the shed; when the weather looks threatening the boards are replaced so that the storm will not in any way deface or pit the bricks. It is also necessary to have doors or boards to place around the sides of the shed, as it is essential that the bricks should dry all through at the same time, and also that all those on the floor shall dry as nearly alike as possible.

If it were not for the doors, in case of high winds, the bricks nearest the side of the shed would dry faster than those in the centre; and also the bricks would dry faster on the outer surface, and when they came to be pressed the hard outer shell would crack, and this would show after burning. The moulds in which the bricks are made are well sanded; also the walk or roll of clay is rolled in sand and formed in such a shape that it can be "slammed" into the mould so that the clay will strike the bottom and spread out against the mould without scraping the sand off.

After the bricks are moulded and dried just sufficiently to enable them to be handled with a pair of paddles (made for this purpose) without spoiling their shape (bricks made one day are generally ready for pressing the following day), they are sifted over with sand as they lie on the floor. They are then taken to the press and re-pressed. When each brick is pressed it is raised to the top of the press mould, when the "off bearer" takes it with a pair of paddles and lays it upon the floor (which is very smooth), piling them at first "five high," that is, the bricks are piled one exactly on top of the other (see Fig. 37) until they reach five bricks in height. This is so done in order that they will dry straight and not be warped or twisted. After the bricks have remained in the "five high" packs or piles until they are dry enough to be handled with the hands without breaking them, they are repacked in a style called "pigeon packing;" this is on edge, and two on two (see Fig. 38). This is done so as to hasten or facilitate drying. When they have been dried in this manner sufficiently for further handling, they are packed on barrows in two rows on their edge, and two high. They are then thoroughly rubbed with the hands and wheeled into the packing sheds, where they remain until they are perfectly dry; this being absolutely necessary before placing them in the kiln. They are now ready to be taken to the kiln for burning.

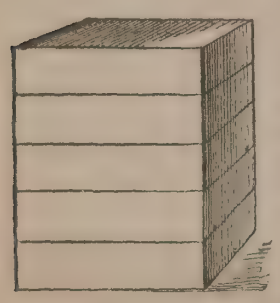


Fig. 37.

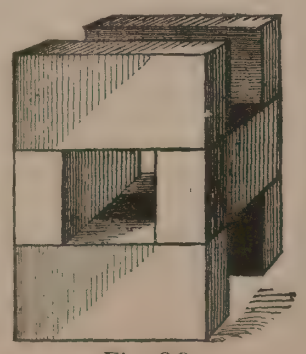


Fig. 38.

They are so placed in the kiln, if a common kiln or "clamp" be used, that they will receive the best color in burning. This position is in the heart of the kiln and above the arches or flues. Here they are set three on three (see Fig. 39), while common bricks are set as in Fig. 40. The idea in setting the pressed bricks in this way is that on one of each three bricks you can get two good faces, and on two of them, one good face each, without fire marks; while in the manner of setting common bricks both faces are more or less fire marked, the upper surface not being as much defaced as the under surface, which gets the full benefit of the fire. After the bricks have been burned they are wheeled out of the kiln into the sorting shed, where they are "assorted to the shade," the general number being fourteen shades, the determination requiring a skillful man with an eye accustomed to distinguishing the shades.

Fig. 39.

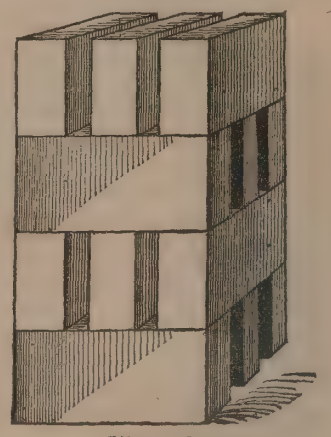
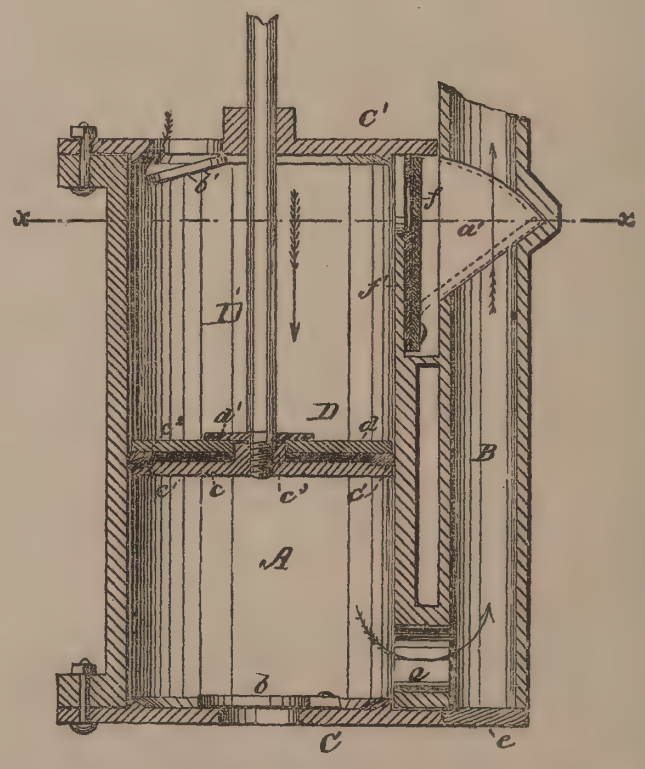


Fig. 40.

They are "sold by the number;" there being great variety of tastes in this particular. The lighter shades are generally used for inside work, such as ranges, etc., and for "bonus buildings," while the dark ones are used for pavements. The most important thing in making good press bricks is (after the clay) the care in handling; and the saying is that 50 cents worth of care in making will add $4.00 to $5.00 per thousand in selling. The best pressed bricks could be first moulded by tempered clay brick machines if they could be properly sanded, as they are clear of flaws. The best front bricks are made in Baltimore, Philadelphia, Trenton, N. J., and Wilmington, Del.; their superiority being due both to the clay and sand, and to the care taken in making. In most other places the object seems to be quantity and not quality.

G.

(To be continued.)



IMPROVED DOUBLE-ACTING, ANTI-FREEZING, FORCE PUMP.

The invention to be described herewith is claimed to be an improvement upon that form of pump in which two inlet valves are employed with but a single outlet-valve arranged in a side pipe which opens into both ends of the cylinder. Of the letters shown in the illustration, A represents the pump cylinder, B the side pipe in which is located the double-acting outlet valve, *f*. The cylinder and pipe referred to are cast in a single piece, the pipe being removed from the periphery of the cylinder so as to leave an open space between, throughout the length, with the exception of the points *a* and *a'*, where they connect and form the exit ways for the discharging water.

C, C', are the cylinder heads which contain the inlet valves, *b b'*, and are bolted to the flanges of the cylinder. D and D' are the piston and piston rod. The former is made up of the disk, c, which has a groove, *c'*, at its periphery to receive the packing ring, c^2, a central boss, c^3, and the plain faced disk, *d*, all of which are held together by the piston rod screwing into the boss, c^3, and drawing the same toward the washer, *d*.

The discharge pipe, B, is furnished, as already stated, with the double acting valve, *f*, which, when the piston rises, rests upon the inclined seat of the chamber, *a'*, as shown in dotted lines, and acts as a check-valve; while on the contrary, when the

piston descends and forces the water out of the passage, *a*, the valve, *f*, rises and closes the opening above the piston between the cylinder and discharge pipe.

The cylinder is intended to be submerged, therefore anti-freezing. In order to prevent rusting and excess of friction, the cylinder is lined with porcelain. That this lining can be applied, the patentee * casts the pipe and cylinder in one piece with both ends of the cylinder and pipe open, and with the pipe so far from the cylinder that the latter will not be affected by any contraction which might be occasioned by the cooling of the former. In applying the porcelain to the cylinder, the metal must be brought to nearly a melting heat, and if the cylinder were of unequal thickness, as a pipe adjacent to the cylinder and cast in the usual manner would necessarily make it, the cylinder would, on cooling, be drawn from its true shape and be unfit for use.

The casting of cylinder and pipe in one piece is one of the economical features that are claimed. O. C. W.

EXTENSION LADDERS.

Rapid increase of population and growth of cities has rendered ground so precious that it has been considered necessary to erect buildings from three to ten stories high, to serve as homes, warehouses, factories, etc. The situation of any unfortunate being who chances to be caught in the upper stories of a burning building, in which the stairways are invaded or destroyed by the flames, is truly dangerous and pitiful. To devise means by which the rescue may be accomplished, while facility is afforded for fighting the fire at a vantage, has been a problem with many attempted and many partial solutions. The production of a ladder to reach the windows in any of the uppermost stories at will, demands portability, lightness, strength, rapid and easy extensibility, and simplicity. The successful combination of all these elements is difficult of attainment. Extension ladders either rest upon the sill or wall which they are to reach, or are self-supporting. The former are the more simple, but dangerous in case of walls falling; and the latter are the heaviest, but most useful.

The differences among those requiring support, are chiefly in the modes of fastening together the sections of which they are composed; nearly all of them requiring to be "up-ended" and raised, after joining, in the same manner as simple ladders. The hook and ladder trucks on which these ladders are carried differ somewhat in their construction; in some, the sections being carried on edge, and in others, on their faces or flat sides. The former mode is greatly to be preferred, as permitting the withdrawal of the longer ladders, which are generally the first needed, or of any one, without disturbing the others or removing the axle of the tiller-wheel. In some, however, of those carrying the ladders on their faces, each ladder rests upon a separate set of rollers and may be withdrawn separately; and a rigid frame is thus secured; but in most of these, the tiller shaft passes through the rungs of all the ladders, thus preventing the removal of any one until this axle is first withdrawn.

The sections, decreasing in length, weight, and strength, are generally fastened together by passing the butt of one into strong iron sockets either on the face of, or between, the ends of the other. The latter mode diminishes the width and capacity of the upper section, without materially decreasing its weight. For strength and security, the butts of each section should be banded, and shod with iron points.

When these ladders can be used as hose-elevators, and can be lengthened or shortened without taking down, their usefulness is increased.

SCOTT & BRANSON LADDER.

The Scott & Branson telescopic ladder has a double set of rungs front and back in the lower section; between these the upper section slides, being moved up and down by a rope passing over a pulley on the top rung of the lower section, as in the Bangor ladder. A suitable stop-catch holds the sliding ladder at any desired point.

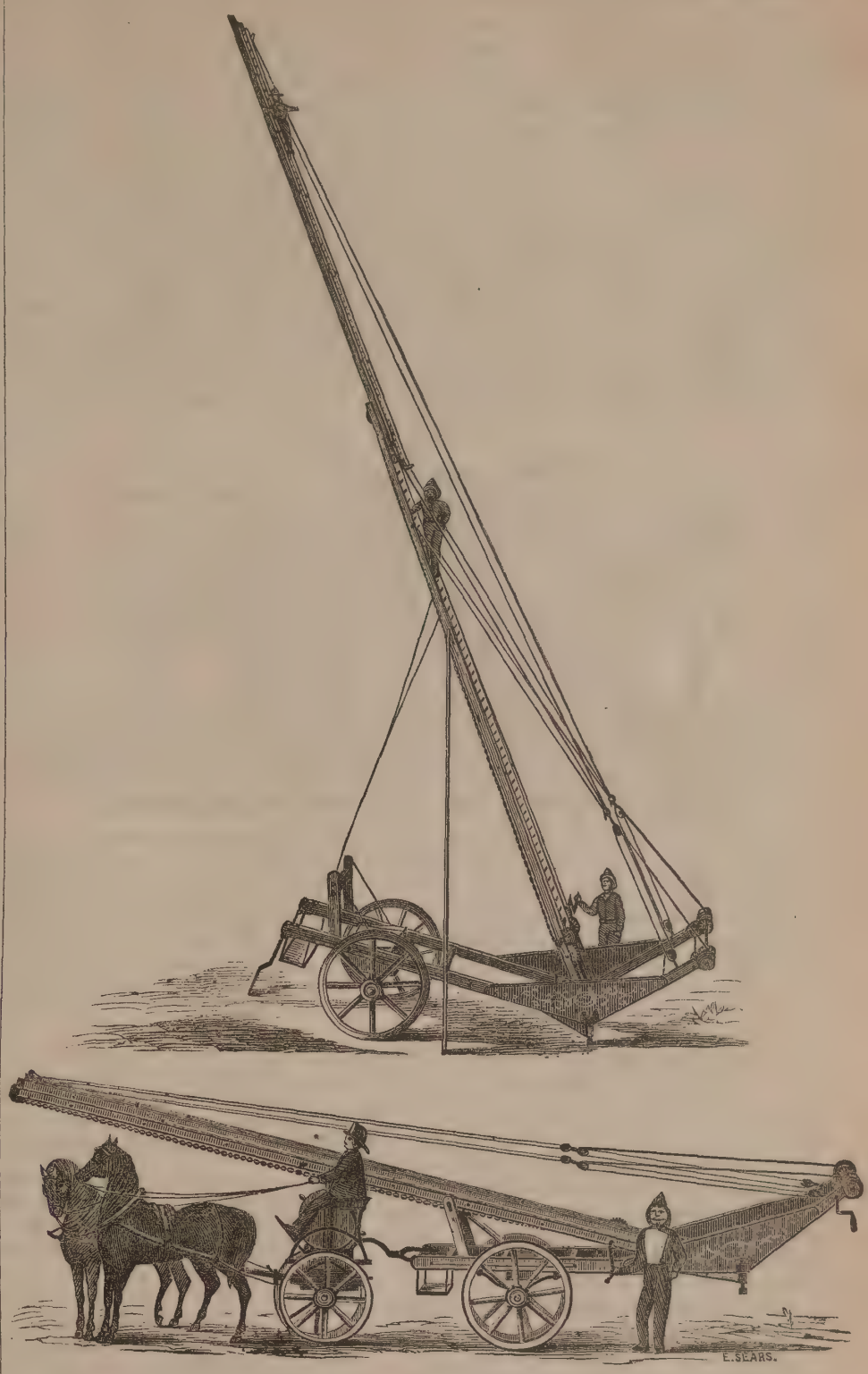
The remainder, or "self-supporting" extension ladders are not removed from the truck on which they are transported. In order to preserve the balance of the machine while the weighted ladder leans forward and outward, weights, guys, and braces are employed. The principal designs are those of Skinner, Porta, Pine, Watson, and Pritchard.

The Watson & Perry Ladder is shown in the accompanying cuts—one representing it as running, and the other as elevated at a fire. The truck, which runs on four wheels, consists of a frame in two parts. The front part is the hose cart and engine tender, and to the hinder part is affixed the main ladder, thirty feet in length; and upon this works a slide ladder of equal length, raised and lowered by a winch at the foot; and from the slide ladder rises a socket ladder 16 feet long. To each side of the slide-ladder, and projected therewith, is affixed a pipe for the hose, with a screw top and bottom, to which the hose and branch-pipe may be readily attached. From the top of each ladder extends a forty-strand wire rope fastened at the other end to a windlass on a frame. By this the ladder is given any elevation required, and held firmly. When the machine is housed or running the triple ladder is in a horizontal position, affording room beneath for transporting a number of extra ladders, seven lengths of hose, 500 lbs. of coal, and the usual complement of hose, axes, picks lanterns, etc., and having an extreme length, horses included, of only 32 feet, allowing it to be turned without a tiller, in a short radius. When the fire ladder is to be used, the withdrawal of the pin connecting the two parts of the truck, brings the ladder, turning on the axle of the hind wheels, to the ground at an angle of 45 degrees.

It may thus be wheeled, by two men, upon a smooth or rough surface, into any position, and raised to any height from 30 to 70 feet, resting upon the earth for a base, and being self-supporting. "At a trial in Brooklyn it was run up, unlimbered, fixed, and a man placed by its help on the top of a high building within 90 seconds."

The Pritchard Ladder employs in its construction the principle of the jib-crane, the lower or main ladder constituting the boom, and the extensions, which slide on independent rollers below the main ladder, may be attached by any desirable method.

* Henry M. Wyeth, Richmond, Ind.



WATSON AND PERRY LADDER.

The main ladder or "boom," has between the butts a strong worm-wheel keyed to an immovable axle. A worm gearing on a bed plate raises and lowers the ladder in the vertical plane; while a second worm gearing revolves the bed-plate and ladder in the horizontal plane. It will be readily seen that the ladder will reach any point, at any angle in height, or in any direction; merely requiring stays or braces to afford a firm base. These last are telescopic, the sliding sections being set to any length from the top of the ladder, by means of a chain and wheel. Each motion is simple and positive. It may be operated in any alley into which the wheels will enter; extending over yards or streets, to the building. By a suitable attachment it may be used as a fire-escape, although not very rapid in the case of a rescued person to climb down the ladder. G.

QUESTIONS OF ECONOMY.

The familiar proverb of "saving at the spigot and wasting at the bunghole" has many an application undreamed of by those who should be most intimately concerned. Manufacturers seem as little concerned about the matter as one would think possible, considering the direct way in which it concerns them. Inventors now seem to properly appreciate the status of affairs, and we see a growing tendency not to produce new things, but to improve upon and save the old. When we consider the consumption of coal to produce steam and of steam to produce work, and the waste of this work by imperfect modes of transmission and application, we do not wonder that inventors of fuel and power-saving devices guarantee boldly to save from 5 to 30 per cent. of power; and we note with secret satisfaction the increasing custom of taking as pay for the economizing appliances the whole or a portion of the saving during a specified time. For instance, a man with a feed-water heater which he could sell at a handsome profit for $100 prefers to take in pay the saving in fuel for one year. He has an immense margin here; for he sees a boiler using 2000 lbs. of coal per day when 1800 would answer if the feed were heated; and his profit would be the 300×200 lbs. $= 60{,}000$ lbs., or 30 net tons, worth $120 delivered. We heard recently of a case where boilers which had been running some years on steady work, with five tons of coal per day, had this reduced to two and a half tons, or fifty per cent., by simply lowering the grate bars from sixteen inches below the boiler to thirty inches, and making some trifling alterations. We knew of a semi-portable engine doing intermittent work and consuming eighteen lbs. of common coal per actual horse-power per hour, partly from bad construction, partly from its intermittent work, and partly and principally from bad attendance.

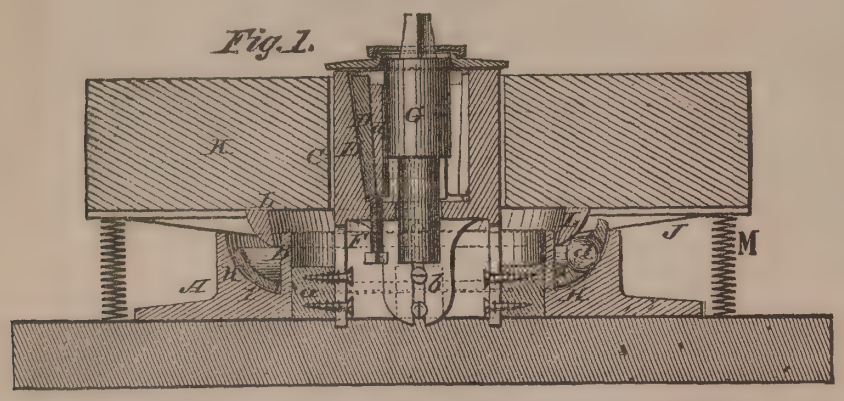
Glass-works are established where all the sand has to be hauled for miles—and is poor sand at that; and we find many a foundry and machine where a gang of labor-

ers (at very slim wages individually, it is true) consumes about one-third of the profit, of the establishment simply in "toting" and hauling castings, &c., from one place to another and back again. We knew a Boston factory to buy its raw material in Baltimore, and, after getting it to Boston, make it up partly in Naugatuck, Conn., then ship it to Lawrence, Mass., then back again to Naugatuck, and then to Boston again, to be tested and shipped to destination. It was a "fat thing" for the railroads, and the Clyde Line, and the telegraph companies, but not for the investors, for the profits on the orders filled were eaten up by expenses, and many hurried orders were lost by inability to get the raw material ordered and started on its tour in time. Furthermore, much of the goods made was bad, because not inspected; and the general superintendent, of course, came under the spirit of Sir Boyle Roche's remark to his constituents, that "No man can be in two places at once, *barring he's a bird.*"

There are some questions of economy which are worked down entirely too fine. Statisticians will figure up that the cost of the cigars smoked in this country would pay off the national debt, and that the price of our other luxuries would, if they were dispensed with, give us each a farm of so many acres, with so many Duchess pear-trees, &c., upon it. No doubt, if one was to live upon oatmeal and dried apples, he might save money to leave for his heirs to quarrel over, but there is a better way yet: to stop all this extravagant waste in manufacturing, and that would enable the present oatmeal eaters to *live*, not merely exist.

G.

Fig. 1.



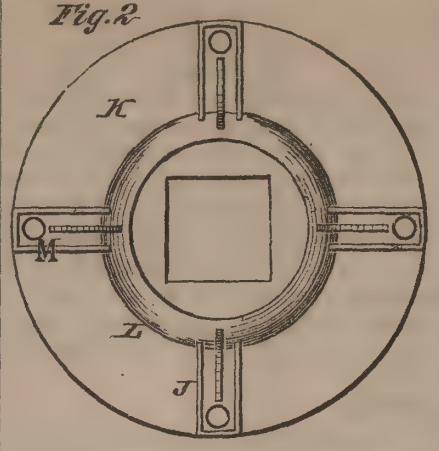
IMPROVEMENT IN BALANCING AND ROCKING MILLSTONES.

Patented April 3d, 1877, by Charles E. Benade, of York, Pennsylvania.

"The invention consists in the construction and arrangement of devices whereby the bed-stone becomes so balanced that it conforms to the movement of the upper stone, causing a rocking motion of the bed-stone without interfering with the rotation of the spindle or allowing dust or flour to pass below the bed-stone.

In the accompanying engravings, Fig. 1 is a central vertical section; Fig. 2 is a

Fig. 2.



bottom view of the bed-stone. *A* represents the annular bed-plate, provided with suitable bolt-holes for fastening the same. *B* is the inside upwardly-projecting flange of said bed-plate. On this flange are cast four lugs, *a*, to support the bush *C*, this bush being cast with four vertically slotted legs, *b*, by which the bush is bolted to the lugs *a* with two bolts through the slot in each leg, which admits of the bush being raised and lowered to suit any thickness of bed-stone. Within the bush are followers, *D*, of cast-iron, working on inclined planes, *E*, and adjusted up and down by means of screws, *F*, as shown. Each follower *D* is provided on its face with packing, *d*, made of suitable vulcanized fibre. *G* is the spindle of the upper or runner stone. Around the flange *B*, in the top of the bed-plate *A*, is formed an annular depression, having one side perpendicular—namely, that side which is formed by the outside of the flange *B*—while the other side is made one-fourth of a circle, it being formed of a concave flange, *H*, concentric with the flange *B*. In the concave *H* is then placed a cast-iron ring, *I*, made to conform to the concave, and in this ring are circular openings to receive balls, *d*. The openings in the loose ring *I* are intended to keep the balls in position, at the same time allowing them to move slightly, as said openings should be of slightly larger diameter than the balls. The ring, also lying loose, adjusts itself to any motion required.

K is the bed-stone, to the under side of which is cemented a cast-iron spider, *J*. This spider has a convex circular flange, *L*, the curvature of which is about one-fourth of a circle; and this convex flange rests upon the balls *d*, causing an oscillating motion of the bed-stone as it comes in contact with the runner.

M, in Fig. 1, represents two or more gum or spiral springs, or any other elastic substance applied underneath the bed-stone, near the outer edge, and resting on the timbers supporting the mill-burs. These springs are intended to keep the bed-stone perfectly in balance and level, and preventing too free an oscillation, thereby avoiding a back lash, which prevents the bed-stone from keeping in face.

By means of these devices the bed-stone is automatically made to conform to the movement of the upper stone by the rocking motion of the bed-stone, without interfering with the rotation of the spindle.

By the construction of the bush the followers will adapt themselves to the spindle, keeping it tight and in position by simply loosening the screws *F*."

THE SLIDE VALVE.

By JOSHUA ROSE.

XIII.

The wearing surfaces of the respective valves are given in table number 12, the valves being allowed to overlap the ports an inch at each end of the ports. The wearing surfaces of the seats are given, so far as concerns the bridges, between the cylinder ports only, because the width of seat face outside of the steam-ports varies considerably in practice. The surface of the bridges, however, always wears faster than the surface outside the ports, and furthermore the bridge surface always wears hollow in its length, as well as hollow as denoted by a straight-edge placed across the cylinder face and at a right angle to the length of the port.

TABLE 12.

Fig.	Sizes of valves. Inches.	Area of valve. Sq. inches.	Area of bridges. Sq. inches.	Valve travel. Inches.
21	7½ x 17	127·5	15	5⅜
22	7¾ x 17	131·7	15	4½
23	10 x 17	170·0	15	4½
24	8⅜ x 17	150·8	15	5
25	7½ x 16	120·0	14	5
26	7½ x 16	120·0	14	5
27	8⅝ x 18	145·2	16	5

In connection with this subject, however, it may be observed that while the larger the valve area, the greater the wearing surface, at the same time the pressure upon the back of the valve becomes by reason of the increased area the greater. Furthermore, the greater the valve travel, the greater the wear; hence the area of wearing surface upon the bridge face is the most important element. The capability of a valve to resist abrasion under a given duty depends largely, also, upon its strength and shape, as well as upon its dimensions and travel, as the following considerations disclose: The friction of a valve to its seat depends upon the pressure with which it is forced to its seat, and this latter will depend upon how closely it fits to its seat. Now these elements vary in every case, and even were this otherwise, we could not determine the equivalent of friction due to the pressure, because the dryness of the steam and the degree of lubrication are by no means constant. In the first place, two quite smooth and true cast-iron surfaces placed in contact will slide one over the other more easily when absolutely dry than when *slightly* lubricated.

The experiments of General Morin on the friction of various bodies without an interposed film of lubricating liquid, but with the surfaces wiped clean by a greasy cloth, have been summarized by Professor Rankine in the following table:

	Angle of repose.	Friction in terms of the weight.
Metals on metals, dry	8½° to 11½°	0·15 to 0·2
Metals on metals, wet	16½°	0·3
Smooth surfaces, greased	4° to 4½°	0·07 to 0·08
Smooth surfaces, best results	1¾° to 2°	0·03 to 0·36

In a paper, of which an abstract has appeared in the *Comptus Rendus* of the French Academy of Sciences, for April 26, 1858, M. H. Bochet describes a series of experiments which have led him to the conclusion that the friction between a pair of surfaces of iron is not, as it has hitherto been believed, absolutely independent of the velocity of sliding, but that it diminishes slowly as that velocity increases.

If we class the conditions under which a slide valve operates under the head of "metals on metals, dry," we are confronted at once with the question: For what reason shall we select the co-efficient as 0·15 in preference to the 0·2, or *vice versa?* If we class those conditions under any other of the headings in the table, where are we to get a co-efficient of 0·15? And if, as M. H. Bochet concludes, the co-efficient varies with the velocity of sliding, how can we assume a fixed co-efficient for a slide valve when its velocity of sliding varies with every variation in the speed of the engine, as well as at every inch of its movement? In the case of slide valves, however, the weight upon the valve is not a dead weight, but live steam which will find its way beneath the surfaces and remain there.

In Appleton's "Cyclopædia" occurs the following: "Two glass or metal plates with well ground surfaces, when pressed together, will adhere with such force that the upper one will not only support the lower, but an additional weight will be required to separate them. The amount of this adhesive force has been measured by recording the weights necessary for their separation. The records of the old experimenters on this subject are worthless, because they placed a lubricating fluid (oil or fat) between the plates; they found thus the cohesion of the oil or fat, and not the adhesion of the plates. In later times, Prechtl, in Germany, has made the most careful experiments in this line; he took polished metal plates of 1½ inch diameter, suspended the upper one to a balance, brought it to an equilibrium in a horizontal position, and attached the lower plate to a support beneath it. Both plates were then brought into contact, so that the flat polished surfaces covered one another perfectly, and the weights required in the scale, at the other end of the balance beam, to separate the plates were the measures of adhesion. He found thus the following remarkable law: The adhesion between two plates of the same material is the same as that between one of the plates and any material which possesses a less adhesive force. Prechtl found also that an attraction of the plates manifested itself at an appreciable distance before actual contact, and he even measured the amount of this attraction at the distance of $\frac{1}{24}$ of an inch by means of weights in fractions of grains. The suspended plate, when brought within this distance, was attracted with an accelerated motion till the contact took place with a slight concussion. The idea that the pressure of the air was the chief cause of the adhesion of two such plates, as it is in the case of the well known experiment with the Madgeburg hemispheres, was set at rest by Boyle, who suspended the adhesive plates charged with weight in the vacuum of and air pump; the plates were not separated, while the hemispheres held together by the vacuum alone fell apart.

At the Centennial exhibition, and at the American Institute Fair, 1876, I exhibited some very true surface plates, their sizes being 12×8 inches, and the weight of each about 20 lbs. If one of these plates is lowered vertically upon the other, the surfaces being clean and dry, and the plates standing level, it requires about one ounce to slide the top plate upon the lower one; with the surface very slightly lubricated, it will require any where between 50 and 100 lbs. to slide the top one when lowered vertically, while if freely lubricated it will take about 5 lbs. to slide the top plate. If, however, the surfaces are wiped clean with oil and rag and are then wiped dry with the rag, and if we then place the plates in contact at one corner only, and slide the top one over the other, it has taken 341½ lbs. to slide one over the other, as appears from a test made by Messrs. Fairbanks upon their standard scales at the Centennial.

In all these experiments it is the closeness of the surface contact which determines the pressure together of the plates. It is not to be presumed, however, that these plates are in perfect contact, and hence there is air, to some extent, between them; and it is only reasonable to assume that, if they had, instead of the atmospheric pressure of about 15 lbs. per inch upon them, the 130 lbs, per inch, under which many slide valves operate, they would be in more perfect contact, and would require more power to slide them. In other words, the co-efficient of friction would be increased in proportion as the air was more perfectly excluded from between the surfaces; providing, however, that there were no elements tending to warp the plates out of truth, and therefore to impair the contact of the surfaces and thus admit the pressing element, be it air or steam, between them. In a slide valve, however, there are several elements which preclude the possibility of the surfaces of the valve and the seat being of a perfect fit, and these I will now separately discuss.

(*To be continued.*)

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

The New Asiatic Railway.—The *North American* has the following interesting details concerning the Central Asian Railway which has just received the formal sanction of the Czar: The road commences at Moscow and is fully completed to Samara on the Volga, through Lower Novogorod, 600 miles. The original plan continued from Lower Novogorod through Kazan to Ekaterineberg, east of the Ural Mountains, some 800 miles. The new concession, however, running south-eastwardly from Novogorod through Samara, reaches Orenburg on the Ural River, 600 miles, then follows a curve of that river due east to Orsk, which is 150 miles east from Orenberg, 300 south from Ekaterineberg, and 600 from the Caspian by the windings of the Ural. This is the termination of the European and the beginning of the Central Asiatic road, of which so much has been said for a long time. From Orsk the road continues south-eastward to Tashkent in Khokan, about 800 miles—through swamps and deserts, over mountains and rivers, which require enormous bridging, tunneling, piling and excavating, and thence eventually into Cashgar, where an intersection is made with the contemplated road from Ormus, in the Gulf of Persia, which, crossing Afghanistan into Cashgar, is aimed toward Pekin. The route now sanctioned simply runs a little north of that originally devised in Eastern Europe, and east of that formerly outlined in Western Asia.

It is probable that this undertaking is mainly military. The earliest route left Ekaterineberg for Omsk, Tomsk and Irkoutsk on Lake Baikal; then using an opening in the Great Altai chain, reached and followed the Amoor to its mouth, with a branch from the lake south-east of Pekin. This traversed nothing but Russian territory, and its political, military, commercial and general uses are patent. The authorized plan secures Turkestan and strengthens Russian conquests there, but gains no outlet on and makes no approach toward the Pacific. It may be that the original and greater enterprise is left for a pacific day, and that the last is driven foreward as it is for immediate military advantages. Labor can of course be obtained from China if the means for payment are provided. Considering the terrible costs and uncertain duration of the Turkish war, and the condition of Russian finances, the new scheme is very wonderful. It lies outside of British territory, but so challenges the trade of India with Western China that India will doubtless see fresh reasons why the Empress should take part in the war or subsidize new railways.

The Welland Canal.—This work is progressing satisfactorily, although not as rapidly as was at first hoped, owing to certain obstructions that were not foreseen. The work now in progress will, when completed, result in the establishment of a navigable canal with locks 270 feet long and 45 feet wide, with 14 feet depth on the sills, the canal proper having a width of 100 feet at the bottom, with a depth of 15 feet. For the present the depth of the new canal between the locks is thirteen feet. The locks, which can hereafter be raised with moderate expense, are at present constructed with 12 feet on the sill. In regard to the details of this work the Chicago *Railway Review* says that the entrance and other locks not coming within this category are constructed with a depth of 14 feet. The new canal leaves the present line and continues from May's Ravine on a separate location 8¾ miles, and is one-third of a mile shorter than the present canal.

Work is vigorously pushed foreward on all the sections. Section No. 36 embraces the enlargement and deepening of Port Colborne harbor or Lake Erie entrance to the canal, including the extension of the west pier about 400 feet further into the lake; deepening the entrance channel from the lake inward; rebuilding the superstructure of part of the west pier, and the whole of that on the east side; constructing a beacon on the south-east side of the entrance, and building four detached blocks of pier work between it and the outer end of the present east pier; renewing and rebuilding about 700 feet of the west docking; deepening and enlarging the basin, etc.

The channel from the lake northward to about the southern line of the contemplated enlargement of the basin is to be sunk to a depth of 17 feet below low water line, and from the latter place to the north end of the basin the depth will gradually diminish to 16 feet at a time when the water stands at 12 feet over the miter-sill of the present lock. In excavating through the rock, the mode adopted has been to drill and blast from the deck of a vessel, held in place by anchor timber resting on the bottom, and subsequently removing the loosened material by an ordinary scoop dredging machine. This system has been so far quite successful, owing in a great measure to the use of nitro-glycerin as an explosive and the skillful arrangements made in conducting operations in all their stages. Still, with all the care and precautions adopted in storing and handling the nitro-glycerin, an explosion occurred on the 30th of October last, by which one man was killed and considerable damage done to property in the village of Port Colborne. Fully one-third of the rock has been removed and a considerable extent of ordinary dredging done. The time for completing the work was to have been the spring of 1877; but it is now understood that it will not be ready before the opening of navigation in 1880. In conclusion the *Review* says: "When the improvement is completed vessels of the largest class can be locked down from Lake Erie into Lake Ontario, and *vice versa*, and, with the enlargement of the St. Lawrence canal, ships of over 2500 tons burden can clear from Chicago for any part in the world, and return with cargoes shipped on through bills of lading, thus making this city the grand port of entry for an immense fleet of vessels and a direct trade, the magnitude of which cannot be estimated nor approximated at the present time."

However much this may be desired, it is not likely to take place to any considerable extent, because of the different requirements of lake and ocean navigation. The models and rig which are altogether best for salt water are not as well adapted for fresh water navigation; hence the lake tonnage will not probably make foreign voyages, although it may be pretty extensively employed along the Atlantic coast.—*Iron Age.*

Steam Heating a City.—The Lockport *Union* desribes the progress made in the introduction of the new system as follows: The construction of Holly's apparatus for heating the city progresses satisfactorily to the shareholders. The plan adopted is calculated to heat all buildings within one-fourth of a mile in all directions from the location of the boiler. The saving will be in coal and stoves, and the great wear and tear from their use. Mr. Holly thinks the cost will be no more than one-half to two-thirds that under the present system. His figures, which have been published, are very plausible. The boilers, which we will not attempt to describe, are placed in a new and substantial brick building, erected for the purpose, on Elm street. The generating apparatus looks quite formidable, and capable of producing heat sufficient to keep all Lockport in a sweat. From this fountain of heat the supply is forced through pipes laid under ground to the buildings which are to be warmed. The main pipe, constructed of iron, is in size about five inches in diameter. Around the pipe is wound hair cloth one-half to three-quarters of an inch in thickness, and over this is wrapped heavy Manilla paper. Thus repaired, the pipes are laid in hollow logs, which are covered with zinc. It seems impossible for any considerable amount of heat to escape, and when the pipes are once heated the waste cannot be very great. At proper intervals are located stations or receiving boxes, the pipes extending and leaving the station at opposite sides, so that a foot or so of intervening space permits the expansion and contraction of the pipes without injury to the general works. From the stations the heat is transmitted to the buildings, and attached are receptacles for drippings.

Transmission of Power by Shafts and Ropes.—The power lost by transmission from the prime motor to distant work is a matter of great importance. Our readers will be interested to know that the advocacy of ropes for transmission, to which we have formerly alluded in these columns, is still maintained. At a recent meeting of the English Society of Engineers, Mr. H. Robinson read a paper in which the following points were made. As regarded the transmission of power by shafting, etc., the results of several experiments and calculations showed the loss to be from 32 to 37 per cent. The application of ropes as a means of transmitting power at Oberusel, near Frankfort-on-the-Main, at Logelbach, in Alsace, at Schaffhausen-on-the-Rhine, and at Fribourg-on-the-Saone, was next described. The loss of power by transmission by a single wire rope was estimated to be about six per cent. It has been stated that the cost of ropes was only one-fifteenth that of an equivalent amount of belting, and only one-twentieth that of shafting. The wear and tear of ropes, together with the necessity of avoiding steep inclinations where the distances were long, lessened the advantages of that system. On the other hand, the loss of power in transmission by ropes, varied only as the velocity, whereas, either by compressed air, or by water, the loss due to friction increased as the square of the velocity. The application of rope gearing to transmit the power from the prime mover to machinery in a factory, in substitution of toothed gearing was also mentioned.—*Min. and Sci Press.*

Proposed Gravity Railway for Fairmount Park.—The Committee on Park Improvement of the Philadelphia Park Commission, held a meeting at the rooms of the Commission, J. Welsh as Chairman. The project of putting down a footwalk to connect with the lower part of the Girard Avenue Bridge was referred to a committee to report at a future meeting.

There were several designs presented for rustic shelters, but as they were only for structures 10 feet square and less, they were not approved.

The plans of the Park Art Association were approved for the location of four fountains to be placed at the corners formed by the intersections of roads to George's Hill and Belmont Avenue. The plan for the location of the fifth fountain, at Green street entrance to the Park, was not considered.

Plans were presented for the building of a passenger railroad within the limits of the West Park. The proposition that was considered was first presented by Mr. William Wharton. This is to operate the gravity railroad without the use of steam. The original project was to start the cars from the summit head of the old inclined plane a short distance northeast of Chamouni, which is shown by actual level to be lower than the real summit. The cars would then return through the middle ground of the park; the track falling on a nearly uniform grade of 46 feet to the mile to Landsdowne Valley, near the Japanese building.

In order to test the practical working of the plan, the plan was now considered to start the cars by horse-power along the west side of Belmont Avenue, from the house to the summit, instead of using the inclined plane. They will then come back, either by the same straight track or by horse power, or will be run by gravity clear along the most beautiful part of the Park northeasterly to Chamouni, thence returning, follow all the windings of the hills to the place of starting, forming one of the most beautiful trips to be found anywhere in the city. The entire distance thus run will be about five miles. The project has been agitated for six months past, and now seems approaching realization.

Steel in Engineering Structures—STEEL RAILS.—The committee, consisting of Sir John Hawkshaw, Colone Yolland and Mr. Barlow, appointed by the Board of Trade to consider the practicability of assigning a safe coefficient for the use of steel in railway structures, and the correspondence connected therewith, have made their report. They recommend that the employment of steel in engineering structures should be authorized by the Board of Trade under the following conditions, namely. (1) That the steel employed should be cast steel, or steel made by some process of fusion, subsequently rolled or hammered, and that it should be of a quality possessing considerable toughness and ductility, and that a certificate to the effect that the steel is of this description and quality should be forwarded to the Board of Trade by the engineer responsible for the structure; (2) that the greatest load which can be brought upon the bridge or structure, added to the weight of the superstructure, should not produce a greater strain in any part than 6½ tons per square inch. They remark that cases may arise when it will be proposed to use steel of special make and tenacity, and when a higher coefficient than the above might be permissible, but they think those cases should be left for consideration by the Board of Trade when they arise.

Speaking of the economy produced by the use of steel rails on the line of the Grand Trunk Railway of Canada, the London *Colliery Guardian* of May 4, says:

"The experience of the Grand Trunk in the matter of steel rails must also be the experience of the Great Western of Canada, the Northern, the Midland, and the other Canadian railways. The fact has been established beyond the possibility of doubt or criticism that steel rails, and steel rails alone, can enable Canadian railways to withstand effectually the rigors of Canadian winters." It is not, however, equally clear that all the steel rails which may be laid down in future upon Canadian railways will be ordered in England. On the contrary, so far from this being the case, even now we find that in 1876, out of 79¾ miles of steel rails laid down upon the Grand Trunk Railway of Canada, only 32 miles were supplied from England. In 1875, out of 155 miles of steel rails similarly laid down upon the system, 99 miles were supplied from England. Here we have another illustration of the growth of American metallurgical industry and of American competition.—*Engineering News*, iv, 159.

—The work on the Hudson River Bridge is progressing rapidly, about 150 men being constantly at work. The first caisson draws now (May 21) 47 feet of water, and is within about 12 feet of the bed of the river. Courses of timber are being added to it at the rate of about three feet per day. The second caisson has besn launched, and is also rapidly progressing. A third gang of men is employed in arranging the ways for the third caisson, so as, if possible, to avoid the trouble which has been experienced in launching the other two. A fourth gang is employed in getting the derricks and purchases up ready to hoist the stone for the piers, the first load of which will shortly arrive from the quarries in Rhode Island.—*Engineering News*, iv, 163.

MINING, METALLURGY AND MINERALOGY.

A Discovery of Mineral Salt of much interest and importance has, says the *Times*, recently been made at Aschersleben, in Prussia, in the vicinity of the Hartz Mountains. Within the last twenty years the governments of Prussia and Anhalt have been deriving large profits from the working of sundry pits or mines productive of potash salts, situated at Stassfurth and Leopoldshall. Hitherto these undertakings have enjoyed a monopoly, but an independent party of explorers, aided by the diamond rock-boring apparatus, have succeeded in reaching the potash deposits at moderate depths, not far from Stassfurth. The first boring reached what is called the "kainit" portion of the potash layer, which was proved to have a thickness of fifty English feet. As Prussian mining law entitles the discoverers to a concession equal to an area of 2,189,000 square metres, it is computed that this discovery includes about 66,000,000 tons of potash salts. But the explorers, consisting chiefly of English capitalists, have proceeded further, and by means of other borings have obtained the command of an enormous area of these valuable deposits, which are now going to be extensively worked. The discovery is likely to be of great service to chemical industry, by providing an ample supply of one of its staple commodities, the want of which threatened at one time to be rather serious. The extraordinary fertility imparted to the soil by the use of potash manure also renders the discovery a matter of direct interest to the agriculturist. Experience gained in Germany and Holland shows that by the use of the kainit and other forms of potash, land naturally poor can be made to bear extraordinary crops. This system of fertilization has been found peculiarly advantageous in the case of peat lands and moors.—*Engineer*, xliii, 371.

The Direct Process for Manufacturing Steel.—The process of manufacturing steel lately invented by Dr. Siemens of London, and which is claimed to be superior to the Bessemer process, consists in smelting cast iron and iron ore together in a furnace, by which the carbon of the former combines with the oxygen of the ore and leaves the remaining mass free from carbon. From time to time samples of the metal are drawn from the furnace and the progress of the transformation observed. When all the carbon has disappeared, a requisite quantity of "spiegeleisen" is added and the mass thereby converted into steel. The whole operation lasts but 11 hours. Since the metal can be sampled before the addition of the spiegel, any grade of steel can be obtained. —*Revue Industrielle*, viii, 236.

Grecian Marble.—One of the most important minerals of Greece, in ancient and modern times, is the white marble of the Pelikon Mountains, not far from Athens. Nearly all the ancient temples, the admirable Parthenon, the Propylæa and hundreds of statues were made of this marble, which has also furnished the material for the new Academy, the University and many palaces of modern Athens, as well as for numerous ornaments.

An excellent white marble, though difficult to transport, is also obtained from the island of Paxos. It was employed by Phidias and Praxiteles for their famous sculptures, and was called Lychnites lithos, from lychnos, a light or lamp, some authors asserting that the name was applied to it because it had to be quarried with the aid of lamps.

In many other places of Greece valuable marbles are found, of white, green, red, black and other colors.—*Am. Jour. Pharmacy*, (4) vii, 377.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

A Thermodynamic Motor, in which work is done by the mere dilatation of a liquid (oil) without change of state, has recently been constructed by M. Ferdinando Tommasi.

To Remove Odorous Compounds from Mortars, Glassware, etc.—Schneider recommends to wash them with ground mustard and some water. A. Huber finds that ground flaxseed, almonds and other oily seeds have the same effect. The odor of musk, valerian, phenol, etc., is thereby readily removed. A little hot benzine or olive oil is very serviceable for cleaning fish-oil bottles.—*Schweiz. Wochenschr*, No. 13, (*per Am. Jour. Pharmacy.*

Iridescent Mother of Pearl is prepared as follows: A sufficient quantity of water of ammonia to cover the object is introduced into a glass-stoppered vial, and silver chloride is added until no more is dissolved and an excess of it is present. The mother-of-pearl object is now placed in the liquid, the vessel closed and set aside in a dark place. After a few days it is taken out and exposed to direct sunlight, whereby the play of colors is developed in a couple of days. The intensity of the iridescence may be regulated by a longer or shorter maceration in the silver solution. The quality of the mother-of pearl is likewise of great influence upon the result. The object should, if possible, be pure mother-of-pearl; if it contain gold the deposit of silver may be removed by careful treatment with nitric acid; silver-mounting will tarnish, but may be reburnished by rubbing; iron remains unaltered, but brass and bronze are rapidly destroyed in the liquid. According to some authorities, a solution of bismuth sulphide in sodium hyposulphite is also used for coloring mother-of-pearl. —*New Remedies*, vi, 42.

Terrestrial Magnetism of the Weather.—Father Secchi, writing to a friend in Belgium, alludes in striking terms to the remarkable connection between the magnetism of the earth and the changes of the weather. He says that the variations shown by the magnetic instruments are themselves sufficient to indicate the state of the sky. Even where there is no great movement of the barometer, following such magnetic disturbances, there are, especially in summer, changes of the wind, and sometimes storms.

New evidences are now quite numerous of the connection between disturbances in the solar atmosphere and in the earth's magnetism. For the last year or two there have been few remarkable displays of the aurora; and that period has been also one of singularly few sun spots. On the morning after the great auroral display in the beginning of this week, Prof. C. A. Young made an examination of the sun's surface, and found the protuberances in the chromosphere more active than they had been previously for four years.—*Journal of the Telegraph*, x, 179.

The Effect of Machinery upon the Industrial Interests of the World generally, is a subject that frequently engages the attention of the economist. In this connection the following estimates of the labor-saving effects of steam motive-power, made by Dr. Engel, the head of the statistical bureau at Berlin, Germany, will be interesting. According to Dr. Engel, the aggregate steam motive-power at present in use in the world is three and one-half millions horse-power, employed in stationary engines, and ten millions horse-power in locomotive engines, making a total of thirteen and one-half millions horse-power. This force is maintained without the use of animal food, except by the miners who dig the coal and provide the fuel, and the force maintained in the muscles is to the force generated by the product labor as about one to 1000. This steam-power is equal to the working force of 25,000,000 horses, and one horse consumes three times as much food as one man. The steam-power, therefore, is equivalent to the saving of food for 75,000,000 human beings. Again, three power-looms, attended by one man, produce daily seventy-eight pieces of cotton fabric against four pieces produced by one hand-loom worked by one man in the year 1800. Again, a carpenter's planing machine does the work of twenty men. This, of course, is but the merest outline of what is accomplished by the use of steam-power and labor-saving machinery.

Use of Clothes Wringers in place of Presses.—E. Dietrich states in "Apotheker Zeitung" that he has been using cloth wringers for over a year and prefers them to the presses usually employed, in which the margin of the press-cake always retains a portion of the liquid. By straining tinctures, infusions, decoctions, etc,, through a bag, and passing the latter through the wringer, all the liquid will be easily separated, without coming in contact with the hands. Pulp of tamarind, etc., may be rapidly made and, with the use of little water, by passing the material first through a coarse hair sieve, and afterwards, enclosed in a suitable bag, through the wringer.—*Am. Journ. Pharm.* (4) vii, 372.

The Electric Light.—Our Paris correspondent writes: We were present at the Alliance Electric Works to witness an experiment on the new caolin-light, which we had seen in operation at the Physical Society, and which was recently described in *Nature*. The Rhumkorff machine was fed by a more powerful primary current given out by an Alliance electro-motor of three-horse power. The bar of caolin, ignited by induction-spark, was eight centimetres long, and fully equal to eight gas-burners. At the same time three so-called electric candles were in operation, each of them giving about forty gas-burners, and fully equal to five caolin lights. Consequently not less than twenty-lights could be fed at once in separate parts of the same building or at any distance. The light is admirable for its constancy and duration; the quantity of caolin destroyed is quite insignificant—no more than 1 mm. per hour; the thickness of the caolin plate or bar used is not more than 4 millimetres. The electric candles are formed, as is known, by two graphite bars separated by a caolin bar. It was proved that the agitation of the candlestick produces no interruption of the current. Consequently a single Alliance-work machine can feed the three lights required by the regulations for steamers. The graphite pencils are consumed at the rate of eight centimetres per hour, which is a difficulty; but it is expected that any length required may be supplied by means of a proper clock-work. Experiments were tried on the same day at the Palais de l'Industrie for the purpose of illuminating the exhibition of pictures with electric light. The ordinary Gramme machines were set into operation. The light was found steady, but the effect was not quite favorable artistically. It is expected that with the system of light division, an improvement may be effected. The experiments were made in order to test whether electric light may be utilized on the occasion of the forthcoming International Exhibition.—*Nature*, xvi, 113.

Use of Blood as a Fertilizer.—Letters Patent have been issued to M. H. O. P. Lissagaray of Pantin, near Paris, for a process of manufacturing manure from blood. The process consists essentially in coagulating the blood by means of superheated steam and then filtering it through linen cloths stretched over suitable frames. The coagulated mass remaining on the cloth is then submitted to hydraulic pressure in order to free it from the remaining water, and then dried by means of a blast of hot air.—*D. Ind. Ztg.* 1877, 228.

Detection of Mineral Acids in Vinegar.—Herr. G. Witz recommends methylanilin-violet as a test for mineral acids in vinegar. The acetic acid of the vinegar has no effect on this dye-stuff, but free mineral acid at once changes its color to a green or blue-green. It is but necessary to add a single drop of a solution of 5 c. g. of methylanilin-violet in 100 c. c. m. water to, say, 25 c. c. m. of the vinegar to be tested.—*D. Ind. Ztg.*, 1877, 228.

MISCELLANEOUS.

The New Channel Vessel.—An English paper says: "The new twin steam vessel for the channel service has been launched. She is called the Express, and differs in several respects from the Castalia. The superstructure containing the cabin is supported on an arch, which rises from the inner sides of the two hulls, about thirty feet from each end. This arch is divided in the middle, where the two paddle-wheels, each 24 feet in diameter, are supported. The length of the vessel is about 300 feet, and the width 60 feet. Each hull carries a separate engine with a cylinder 63 inches in diameter and a stroke of 6 feet. The draught of water will not exceed 7 feet, and as the number of revolutions at full speed will be 36 per minute, a high speed for such a vessel is confidently anticipated.

The Last Siberian Mammoth.—According to recent news received by M. Sidoroff as to the mammoth discovered in Siberia, the carcase was found in the gold-bearing sands of a gold-washing on the Kundola, at a depth of five mètres. The flesh was very soft and of a light red color when freshly dug out, but soon hardened, becoming like a white clay. It seems to be much impregnated with lime. The digging out of the whole body will be very difficult because of the access of water. M. Polyakoff has already left St. Petersburg for the excavation of the body.—*Nature*, xvi, 113.

Sanitary Question.—The Society for Improvement of Public Health in Utrecht, offers a prize of 100 gulden for the best work on the liquid manure of stables, giving (1) an accurate account of the literature of the subject; (2) a description of original experiments on the means of obtaining from horse urine diluted with water, products which, either as manure or as a chemical preparation, may be brought into commerce in comparatively large quantities; (3) full numerical tables on quantitative chemical analyses made; (4) a thorough treatment of the financial side of the question. The memoirs may be written in Dutch, German, French, or English, and are to be sent, with sealed envelope and motto, to Prof. Dr. Th. Mac Gillvory, Director of the Veterinary School of Utrecht before September, 1878.—*Nature*, xvi, 132.

Rhode Island Manufactures.—Statistics show 2,109 manufacturing establishments in Rhode Island, with $50,000,000 aggregate capital, and employing 56,450 hands, who receive annual wages of $23,707,513. The value of the annual product is $126,659,875, the raw material for which costs $76,715,970, so that the profit over wages and costs of material amounts to $26,236,392, over 50 per cent. of the capital, and an average of $12,995 to each establishment, though other expenses greatly reduce this margin. The cotton factories number 135, have $24,034,209 capital, employ 22,574 hands and produce $38,927,960. There has been a large increase during the past year in the number and production of all the manufactories.—*The Iron Age*, xix, 25.

The Railroads of the United States in 1876—Though the past year has been one of great depression in the railway, as in all the other interests of the country, the aggregate results of their operations have been fairly satisfactory. The number of miles of railroad opened during the year 1876 was 2,856, against 1,919 miles for 1875, and 1,911 miles for 1874. The excess of miles built, as compared with the two preceding years, is due almost entirely to the great activity in the Southern Pacific lines, and in narrow-gauge lines in Ohio, Texas and Colorado. No new lines of any considerable magnitude have been undertaken. The tables which follow will show in what sections there have been any considerable increase.

The gross earnings of all the roads whose operations have been reported, have equaled $497,257,959, against $503,065,505 for 1875. The general result of the operations of our railroads for the last six years is shown in the following statement:

Statement showing Miles of Railroad, Capital Account, Earnings, etc., for six years.

Year.	Earnings.			
	Gross.	Net.	From Freight.	From Passengers.
1876...	$497,257,959	$186,452,752	$361,137,376	$136,120,583
1875...	503,065,505	185,506,438	363,960,234	139,105,271
1874...	520,466,016	189,570,958	379,466,935	140,999,081
1873...	526,419,935	183,810,562	389,035,508	137,384,427
1872....	465,241,055	165,754,373	340,931,785	132,309,270
1871...	403,329,208	141,746,404	294,430,322	108,898,886

Year.	Miles, Operated.	Capital and Funded Debt.	Dividends Paid.
1876...	73,508	$4,468,591,935	$68,039,668
1875....	71,759	4,415,631,650	74,294,208
1874....	69,273	4,221,763,594	67,042,942
1873....	66,237	3,784,543,034	67,120,709
1872....	57,323	3,159,423,057	64,418,157
1871....	44,614	2,664,627,645	56,456,681

It will be seen by the above that, while the gross earnings have fallen off $5,807,546, the net earnings have increased $946,314. This increase has been due chiefly to the great economies practiced in conducting the operations of the roads. Whether these economies have been at the expense of the condition of the roads the future must determine. The introduction of steel rails has doubtless been a considerable element in the cheaper ratio of operating expenses.

There were in operation, at the time of the issue of the first Manual for 1868–69, being for the year ending Dec. 31, 1867, 39,244 miles of railroad, of which 3,938 miles were in New England, 9,552 in the Middle States, 15,226 in the Western, 10,097 in the Southern, and 431 in the Pacific States. The Union and Central Pacific railroads had not been completed. There was not a mile of railroad in Utah, Dakota, Colorado, Washington Territory or the Indian country, where now are 2,136 miles; and in all the territory west of the Mississippi River and east of the Pacific slope, where now are 17,576 miles, supplying the wants of a population of 7,120,000, there were then but 3,968 miles of railroad, with a population of 4,205,000.

Arranged by groups, the increase of railroad mileage and population is shown in the following table:

Table showing the increase of Railroads and Population in the United States for ten years, 1867–1876.

	Miles of R. R.		Increase.	
	1876.	1867.	Miles R. R.	Per cent.
New England States..	5,694	3,938	1,756	44.59
Middle States.....	15,085	9,555	5,530	57.87
Western States.....	37,055	15,226	21,829	143.37
Southern States.....	16,676	10,126	6,550	64.68
Pacific States.....	2,960	431	2,529	586.78
Total, United States	77,470	39,276	38,194	97.25

	Population.		Increase.	
	1876.	1867.	Number.	Per c't
New England States	3,806,850	3,348,000	458,850	13.70
Middle States.....	11,405,000	9,930,000	1,475,000	14.85
Western States.....	15,835,000	11,985,000	3,850,000	32.12
Southern States.....	12,410,000	10,440,000	1,970,000	18.87
Pacific States.....	1,280,000	650,000	630,000	96.92
Total, United States	44,736,850	36,353,000	8,383,850	23.06

It will be seen by the above that, while in the last ten years the railroad mileage has nearly doubled, the increase in population has been only 23 per cent., the railroads having increased more than four times as rapidly as the population.—*From advance sheets of "Poor's Manual of Railroads of the United States for* 1877–1878, *in R, R. Gazette,* ix, 277.

The Eads Jetties.—From the latest reports from Capt. Eads it appears that in 60 days a ship drawing 22 feet of water can pass from New Orleans to the sea. The addition of another foot or two to the depth of the channel will only be a matter of time. The importance of this, not only to New Orleans, but to the entire West, is almost too great for calculation. For years the value of the Mississippi as a means for internal transportation has been limited by the fact that it had no outlet free to the ocean. Vessels built for the general Atlantic trade and of sufficient size to ply economically between New Orleans and Europe, could not get up to the city. The river, which might easily have been the highway of the West to the sea was used mostly for local transportation. With the opening of the 22 foot channel it will be possible for New Orleans to regain her position among the important commercial cities of the world. The benefit to the Western steamboat interest will be enormous. This benefit comes at a peculiarly favorable time, it would seem. For the past few years the business has been very dull, and it is stated that comparatively few boats have been built, while a great many have been broken up. Iron boats are now coming into favor, and if the steamboat fleet is to be renewed or greatly enlarged, iron boats may be expected to be in the majority. The business will therefore revive under exceptionally favorable circumstances, which will go far toward keeping it on a substantial basis. In using iron as a material for the construction of boats and barges to be used on fresh water, we do not meet with the danger of corrosion found when it is used in salt water, and we have a material which seems to meet every requirement and to be almost without drawbacks. The prosperity of New Orleans and the river may be looked upon as assured in the immediate future.—*The Iron Age,* xix, 25.

Weight of a Life in Coal.—We see in the English discussions concerning loss of life in coal mining the following statements: The real cause of this yearly sacrifice of lives is the use of gunpowder in fiery seams. There is a want of precaution amongst miners in employing this explosive, and until they can be brought to understand what their negligence may bring about, "drilling-out shots" and other forbidden acts will continue to be done when deputies are out of sight. Mr. Wynne, in his report for 1875, says that in his district falls of coal and roof have caused 14 accidents, by which 14 lives have been lost, and compared with the loss of the previous year, 23 lives, this is a very clear proof that making managers responsible for the absolute safety of the working places of the mines has had a very salutary effect. In the year 1868, a death occurred for every 103,429 tons of coal raised in England. In 1875, 108,918 tons of coal were raised per life lost; in 1868, 104,566,959 tons of coal were raised in Great Britain, involving a total loss of 1,011 lives, and in 1875, 133,306,485 tons, with a total of 1,224 lives lost, but more men were employed and more mineral raised.—*M. & S. Press* xxxiv, 395.

The so-called Crystal-Porcelain-Cement consists according to Prof. Böttger's report to the "*Frankfurter physik. Vrn.,*" of gelatine dissolved in acetic acid. It is prepared by placing a small piece of clear gelatine in a porcelain cup and after adding a small quantity of acedic acid, slowly heating it until a viscid, perfectly homogenous jelly is formed which on cooling, forms a transparent mass. In order to cement two brocken parts together, the gelatine-like mass is returned to a fluid condition by gently warming and applied by means of a brush to the fractured faces, the latter are then gently pressed together and permitted to lie quietly for 12 or 14 hours.—*D. Ind. Ztg.,* 1877, 238.

Cleopatra's Needle.—Mr. Dixon's agent has obtained absolute possession of Cleopatra's Needle from M. Demetrio. The operations for the removal have commenced.

Protochloride of Sulphur will convert an ordinary drying oil into an elastic solid. A volatile liquid added to the oil at the same time as the protochloride, will be inclosed in the resulting solid, from which it can escape only very slowly. Mr. Mercier has confined in this way as much as 70 per cent. of bisulphide of carbon, and he proposes to employ this ingenious device in checking the ravages of the phylloxera.

—Frick & Co.'s Steam Engine and Boiler Works, Waynesboro', Franklin county, Pa., are running on extra time. They have nearly a hundred men at work daily—12 hours per day in the engine shops and iron foundry, and 13 hours per day in the boiler works. They say that they have more orders for their "Eclipse" farm engine than they can fill.

—Messrs. Chas. W. Ervien & Co., of Philadelphia, have just shipped to Mexico a large steam engine, built by them on an order from a firm in that country. They have several important orders on hand, and report quite an active inquiry for large steam engines.

—Among the enlargements of Philadelphia's foreign trade just announced, is the sailing from the Delaware River for Rio Janeiro of the bark Matthew Baird, loaded at Wilmington with cars for a railroad in Brazil, which were manufactured at the Harlan & Hollingsworth Company's Works, at that city. She is a vessel of about 600 tons capacity, but was unable to carry the whole of the consignment, and another vessel will also be loaded with them. It is not very long ago that Brazil got almost all of her railway supplies in England. Then she began buying locomotives in this country, and recently a Pennsylvania firm carried off the successful bid for railway iron for a Brazilian railway. Now she is buying our cars. It is quite probable that Brazil will thus be soon running a competely American railway.—*Iron Age.*

—Messrs. W. C. Allison & Co., of West Philadelphia, the car builders and tube manufacturers, are now running with 800 men, remodelling refrigerator cars, constructing narrow gauge cars for railroads in South America, and making pipe for various oil lines in the north-western part of the State. At their wharf on the Schuylkill there are at present two large schooners receiving their cargoes of locomotives, which are being shipped to Brazil as fast as they can be loaded.

—The gas pipe works, Newcastle, was to commence operations about July 1st. The manufactory will turn out gas, steam and water pipe, and also oil well tubing.

—Mr. Wooten's patent, by which coal dirt is used for fuel on engines, is said to work very satisfactorily. A train of 125 cars was taken down the Reading road a day or two ago with 85 cents worth of coal.

—The Delaware Bridge Company have contracted with the Pennsylvania Railroad Company for a bridge at Rockville station, to cross the Susquehanna river just above Harrisburg. A. & P. Roberts & Co., Pencoyd Iron Words, make nearly or quite all of the iron. The Edge Moor Iron Company do the fitting and prepare the iron for erection. The aggregate weight of iron will be about 7,000,000 pounds. The bridge will be completed before December next.

—At a joint meeting of the Ohio State Board of Public Works and the Commissioners of Sandusky County Ohio, held at Columbus Ohio June 28, the contract for building an iron bridge across the Sandusky River in the city of Fremont, Ohio, was awarded to the King Iron Bridge Co. of Cleveland. The bridge will consist of three spans, two of 89 feet each and one of 142½ feet, having two roadways 18 feet each and two side walks 8 feet each. Amount of contract $14,775.00.

—The highest point attained by any railroad has been reached in the summit of Loveta Pass, in Sangre De Christo mountain. The altitude of the summit is 9350 feet.

—The Steamship Hibernia, belonging to the Telegraph Construction and Maintenance Company's fleet, has sailed to take up and repair in mid-ocean, the long dormant 1865 Atlantic Cable. This will prove to be one of the most interesting operations in submarine telegraphy ever undertaken, and there is no doubt it will be watched with interest by men of science, and by all shareholders in submarine telegraphs. It may be mentioned that the portions of the cable taken up at the shore end, after having been submerged for 12 years, are in such satisfactory condition as to inspire a large amount of confidence in the minds of those whose opinions are of undoubted weight and value.—*Telegr. Jour.* v, 138.

EDITORIAL CORRESPONDENCE.

EDITORS OF THE POLYTECHNIC REVIEW,

DEAR SIRS: I received to-day a letter from Malte Brun which contains the following. "Vous savez que l'Expedition du Darien commandeé par le Lieutenant de Vaisseau Wise est de retour. Elle a perdu trois de ses membres. Elle n'a pas trouvé du cote des marais de Cacarica la dèpression de la Cordillère qui était annoncée par les promoteurs de l'Expedition, MM. De Gogorza et cie; mais il paraitrait qu'ils en ont trouvé une autre un peuplus loin que l'on pourrait utiliser pour un canal interoceanique."

[The Darien Expedition, under the command of Lieutenant de Vaisseau Wise has returned. It has lost three of its members. It has been unsuccessful in finding the Cacarica Route, or the depression of the Cordillère announced to exist by the promoters of the expedition, MM De Gogorza & Co.; but it would appear that they have found another, a little further off, which could be utilized as an inter-oceanic canal.]

This is precisely what the Navy knew would be the case, and what your Mr. Trautwine published some time ago in your journal. Very Truly.

Washington, D. C., June 19, 1877. J. E. NOURSE.

ANSWERS TO CORRESPONDENTS.

NARROW GAUGE. (C. H. T., Xenia, Ohio). A so-called narrow gauge railway is simply a very common sense road in which a given weight of load is distributed in a narrower and longer space, permitting of lighter engines, cars, rails and bridges, shorter ties, narrower and fewer cuts and tunnels,

etc. If the wide gauge is the best, why not make a 10 foot gauge? And why have 6 foot gauges been such financial failures, and narrow gauge such successes?

STONE BEARINGS FOR SHAFTS. (S. S., Whitehall, Mich.) Soapstone makes a good bearing. If you will include the tiny shaft called an *arbor* by watchmakers, "stone" in the shape of jewels, makes the best bearings. Silicate of magnesia ground, calcined and moulded by hydraulic pressure makes good bearings.

TEST OF IRON CASTINGS. (J. A. F., Chattanooga.) These should have a smooth clear continuous skin, with regular faces and sharp angles; a light bluish gray fracture, close-grained and with considerable lustre; uniform color and texture except that near the skin there may be a gradation to lighter color and closer grain. A fracture mottled either with patches of lighter or darker iron, or with crystalline spots, shows an unsafe casting; air bubbles are worse. The metal should be soft enough to be slightly indented by a blow with a hammer on the edge of the same casting. It should turn or file up smooth, compact, and bright, showing no bubbles or irregularities, and should take a good polish. If a casting contain air bubbles it will not ring clearly when struck over them.

MAKING SMALL CIRCULAR SAWS. (C. E. R., Cleveland, Ohio.) To get up small fine-toothed circulars in great quantity for your own use in grooving, etc., punch out the disks from a strip of steel thread, say 50 of them on a mandrel that fits their center holes tightly, and screw them up tightly. If they are to have say 90 teeth each, take a radial cutter that will make three teeth at once, and cut along the whole 50, as in cutting watch-wheel teeth; then cut the next three, etc. If still larger quantities are to be made, it may pay you to use say 10 radial cutters at once, each cutting 3 teeth, or 30 in all; three cuts will then make you 50 saws, each of 90 teeth.

GRADES OF INDIA RUBBER. (J. E. R., Philad'a.) The more commonly imported grades are known as—Cera scrap, Cutti, African tongue, Niggerhead, Guayaquil, East India, West India, Borneo, Para, and Australian ground gum. Gutta percha is an entirely different gum, although possessing the same chemical constituents in the same proportions. It has not the same physical properties nor is it manufactured in the same way or for the same purposes. The ordinary lead pencils, pen holders, buttons, combs, etc., have not a grain of gutta percha in them; nor are they known in the trade as gutta percha. They are "hard rubber" to the trade; outsiders term them vulcanite, ebonite, etc. They are India rubber, etc., with more sulphur than soft rubber has, and vulcanized longer and and at a higher heat.

HELICAL AND SPIRAL SPRINGS. (J.R.B., Gloucester, N.J.) The spiral is an advancing coil or screw; the helix is a coil lying in a flat plane. Of course such a spring as a bed-spring would be a conical spiral or conical helix. The terms spiral and helix are very frequently confused and interchanged.

NON-CIRCULAR WHEELS. (D. & Co., Lawrence.) Certainly there are such things. There are both elliptical and square spur wheels. The term may sound something like that of "white black-bird," but is perfectly correct. Horace says that "use is the law of language."

KINEMATICS. (F. J. B., Camden, N. J.) This science was named by the great physicist Ampère (in his *Essai sur la Philosophie des Sciences*) from *Kinéma*, motion. Its first and French version was *Cinématique*. In it are treated mechanisms apart from their applications in machines; or at least considered solely as mechanisms.

FILTERING VERY MUDDY WATER. (P. R. J. & Co., St. Louis). Try a "centrifugal" such as dye-works use for drying yarns. Such are made in this city and will certainly work.

RUBBER WASHERS FOR FLANGE JOINTS. (G. L. & Son, Cincinnati). If you strengthen the ordinary washer made of sheet packing, by a thin brass hoop around the inside circle, like an eyelet, you will find it an improvement.

PUMP AIR CHAMBERS. A. T. A., Philadelphia, asks for himself and friends, the cause of the annoyance with air chambers on steam fire-engines, and its remedy. We presume that the rising of the water in the air chamber is alluded to:—a great nuisance, not only by loss of cushion spoiling the steadiness of steam, and straining the pumps, but necessitating stopping the latter and opening a gate to empty the chamber of water. The cause of the trouble is the absorption of the air by the water, under the great pressure (150 to 250 lbs. per square inch); and a spherical air chamber gives more trouble than a conical or balloon shape, on account of the larger surface of water exposed. Ahrens & Co., Cincinnati, now put on a separate air pump to keep up the air supply: but we believe that some of the earlier French machines had a closed rubber air balloon fitting snugly inside the chamber, and while giving the cushion perfectly, rendering absorption impossible.

BIBLIOGRAPHICAL NOTICES.

STRENGTH AND CALCULATION OF DIMENSIONS OF IRON AND STEEL CONSTRUCTIONS, WITH REFERENCE TO THE LATEST EXPERIMENTS. Translated from the German of J. J. Weyrauch, Ph. D. 112 pp., 12mo, four folding maps. Van Nostrand, New York, 1877.

This little work is an admirable *resumé*, special prominence being given to Wöhler's Law, upon which the many new and valuable formulæ are based. The conclusions of many standard authorities are collated, and errors in generally accepted formulæ pointed out. It is a great pity that bridge-builders could not have had and followed this little work long ago.

U. S. GEOLOGICAL EXPLORATION OF THE 40TH PARALLEL. Clarence King, Geologist in Charge. Microscopical Petrography, by Ferdinand Zirkel. Illustrated by 12 plates. Washington, 1876. 296 pp., 4to.

This superb contribution to science, which reflects infinite credit upon all engaged in its preparation and publication, constitutes vol. vi. of the admirable reports of Clarence King. Prof. Zirkel is the founder of the science of microscopical petrography, and this volume, which is the result of a conscientious and laborious study and comparison of American rocks with those of Europe, at the hands of the most distinguished of living lithologists, will rank as one of the most important contributions ever made to American geology.

SELECTED LIST OF U. S. PATENTS.

ORDER.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
Washington, D. C., June 19, 1877.

FRANKLIN B. HUNT, of Richmond, Indiana, having been found guilty of gross misconduct, is, under authority of section 487, R. S., and with the approval of the Secretary of the Interior, hereby suspended from practice before this Office.

ELLIS SPEAR,
Commissioner.

JUNE 12TH, 1877.

Patents issued June 12, 1877, 301. Reissued, 19. Trade marks, 30. Designs, 8. Labels, 4.

191,746. HOUSE HEATING FURNACE WITH COOK STOVE ATTACHMENT. Henry W. Austin and William B. Hosford, Chicago, Ill.

This furnace is of the portable type, and is provided on one side with a cook stove attachment, the flues of which are connected with the flues of the furnace, so that the products of combustion in the furnace may be caused to pass around the oven and under the cook holes, and back again to the furnace. A hood projects above the cook stove attachment, to gather the odors and steam arising therefrom, and a pipe conveys them to the smoke flue.

191,749. PROCESS OF MANUFACTURING CARBURETTED HYDROGEN GAS. J. H. Bowman, Warren, Pa.

Steam is passed into a heated retort containing iron or other suitable metal. Air is passed into another heated retort containing charcoal, coke, or other suitable carbonaceous material. The gases so generated are then passed into a still or suitable chamber and mixed with hydrocarbon vapors generated therein. The gaseous mixture is then passed into and through a third heated retort containing carbonaceous material and metal in suitable form, whereby the gases become chemically combined and fixed.

191,766. MANUFACTURE OF ILLUMINATING GAS. M. W. Kidder, Boston, Mass.

Steam is generated and superheated in passages in the wall of the generator, and is admitted to the ash-pit, and thence to the incandescent fuel in the generator, where it is decomposed, forming carbonic oxide and hydrogen, which are purified and stored in a holder, or are passed directly into a heated chamber with steam, where part of the carbonic oxide is converted into carbonic acid, taking oxygen from the steam and setting hydrogen free. These gases are passed through lime purifiers, and are then stored.

The water gas is enriched by admitting it with oil into a heated chamber, where the two are passed over heated plates, or the water gas is passed up through bituminous coal distilling at a low temperature. Gas is burned in the fire-box of the furnace.

191,769. }
191,770. } PIPE JOINTS. Geo. Matheson, McKeesport, Pa.

One end of each section is bell-mouthed. When the ends are joined a ring is placed around the bell, and the end of the pipe is battered down or calked between said ring and the inner pipe; or, a lead gasket is inserted between the inner and outer pipe and calked.

191,773. INJECTORS. Wm. H. Newell, Philadelphia, Pa.

The spindle to open the steam and water valves is operated by means of cams. The overflow valve is formed of a plug, with its head perforated and enclosed by a sleeve which automatically covers and uncovers the perforations.

191,174. OPERA CHAIR. Robt. H. Ormsby, Milwaukee, Wis.

The seat is folding, and has connected with it, beneath, by parallel rods, a rack or shelf for the reception of hats, etc., which automatically folds with the seat.

191,775. GRAIN BINDER. W. H. Payne, Sandwich, Ill.

This machine belongs to the type of *revolving* binders. It has a revolving arm pivoted at its centre, and carrying hooks at its outer ends. One bundle is bound at each half revolution. The twisting pinion has its sides extended to the points of all the cogs except one, so as to leave two spaces on opposite sides of said tooth for the reception of the band wire.

191,812. ENGINE VALVES. Eugene O'Neill, San Francisco, Cal.

The valve is hollow, and constructed with an interior and exterior face, one half the seat being at the end of a stud which enters the cavity of the valve, so that by a small lift of the valve, a large inlet area is exposed.

191,819. PAPER FOLDING MACHINES. S. D. Tricker, New York.

From a rapidly moving pair of delivery rollers, the sheets are alternately directed by a vibrating switch into rigid diverging conductors, to two pairs of slow moving rollers and sets of tapes, which carry them over rollers, between which they are folded by blades oscillated by cranks. One part of each conductor is pivoted so as to swing aside, and the switch is readily removable.

191,876. DRAIN TUBE. George C. Mesler, Dunellen, N. J.

There are two tubes, one within the other, both set in the same pointed head and both perforated at the lower end. The tube is driven down in the place to be drained until the pointed head penetrates a pervious stratum. The outer tube conveys the water down to this previous stratum, while the air therein finds vent up the inner tube, which extends above the surface of the water to be drained.

191,894. LATHE FOR CUTTING SCREW TAPS. G. R. Stetson, New Bedford, Mass.

The machine is designed to rotate the blank slowly while the threads are being cut, and slowly while the tool is passing over the flutes. Two sleeves rotate upon the lower shaft of the machine. One of these sleeves carries a mall and the other a large pulley, which are connected respectively with the large and small pulleys on the driving shaft. A clutch feathered to the lower shaft (said shaft being connected with the blank holding mandrel by gearing) is caused to engage with the sleeve of the large pulley while the top blank is being threaded, and unite the sleeve of the small one while the cutter is passing over the flutes. Said clutch is operated by spring plungers carried in the rotating disks of an upper shaft.

191,899. PROCESS FOR MANUFACTURE OF PAPER PULP FROM WOOD. James Taylor, Luzerne, and James T. Outtersou, Palmer Falls, N. Y.

The process consists essentially of cutting the wood crosswise of the grain, crushing it endwise of the grain, picking it, and subjecting it to the action of steam pressure.

191,907. LOOM TEMPLES. James E. Waterbury, Rensselaerville, N. Y.

The temple is adapted to be used in the weaving of tubular fabrics. The temple bar is provided with rollers at its outer end, and with projecting rods around which the filling is looped. A spring bar is secured to the framing of the loom at each end of the breast beam. This bar carries two rollers, one above and the other below the fabric, which work between the rollers of the bar. A guide roller bears against each end of the bar. A bracket attached to the lathe operates the spring bar and moves the temple.

191,938. MILLSTONE DRESSING MACHINE. John C. Cookson, and Lewis Rastetter, Fort Wayne, Ind.

The tool holder is reciprocated longitudinally, and is automatically carried across the bed plate and depressed by an arm working in a slot. The extension of the bed plate affords additional resting surface for steadying the device.

191,947. MORTISING MACHINE. Alfred D. Eddy and H. J. Stoltzenbach, Tiffin, Ohio.

The material to be mortised is clamped upon a reciprocating concave table, connected by a tongue and groove to a convex bed, by means of a cam lever pivoted to the head of a post fixed in said table, and acting upon a bar hinged to the side of the table. The tool is adapted by means of opposite grooves and a notch in its cutting end, to be sharpened without decreasing the diameter of the tool at that point. The tool is mounted in a sliding mandrel and advances as it rotates to deepen the mortise.

191,691. MECHANICAL MOVEMENT FOR CHANGING SPEED. A. F. Harvey, Kirkwood, Ind.

There are two concave conical wheels mounted upon axes at right angles to each other in such relative positions that the foci of their adjacent concave segments will coincide, and their smaller ends toward the axial intersection. The concave face of these wheels are armed with several rows of cogs of uniform pitch, and a spur gear of diameter equal to the distance between said conical wheels is mounted in a pivoted frame whose axis intersects the common foci of the curved faces of said conical wheels, so that said spur gear may be swung on the axis of its frame so as to engage with either set of cone gears and increase or diminish speed accordingly.

192,929. CULTIVATORS. P. S. Tartt and G. F. Wilson, Wingos Station, Ky.

This cultivator has standards with sharp forward edges, and flat soled shovels slightly convex on their upper surfaces. The rear edges of the shovels are sharp. The purpose of this implement is to cultivate sod land or young growing cereals. The shovels run a few inches below the surface, so as not to injure the roots and loosen up the soil, so as to admit air to the roots. The inventors assert that experience has shown the yield to be nearly or quite doubled by this treatment.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, JULY 14, 1877. NO 2.

GOVERNORS.

From Knight's *American Mechanical Dictionary* we take the following illustration and description :

The governor is a device which regulates the admission of steam to the engine according to the rate of motion. The intention is to maintain uniform velocity, and any acceleration of speed above a given rate causes a valve to be partially closed, diminishing the area of steam passage ; contrariwise in case of flagging in the speed of motion of the engine. The favorite form of governor has a pair of balls suspended from a vertical shaft, so as to swing outward when the shaft is rotated. The greater the speed the greater the centrifugal force, and consequently the farther the balls depart from the axis of rotation. The inclination of the ball arms is made effective in working the valve.

This use of the device of the two suspended revolving balls, whose circle of revolution widens as the speed of the engine increases, is due to James Watt, who adapted it from an ancient device in windmills.

The full-page engraving shows fifteen variations in form and structure of the ball-governor, two forms in which a propeller wheel acts in a liquid, and one form in which the pressure of steam is directly upon the valve.

In *a* the balls receive their rotation from the bevel gearing above, increment of speed causing the balls to fly outward and raise the sliding sleeve on the spindle. To this sleeve is connected the end of a lever arm whose vertical oscillations are communicated to the butterfly or throttle valve, as in Figs. *k* or *l*.

In *b* the balls receive rotation by the bevel wheels, next below the sliding collar. To the collar is attached a sleeve on which the lower bevel gears remain at rest as long as the pin on the said sleeve is not in contact with either of the studs projecting from the upper and lower surfaces of the respective bevel wheels. This is the position shown in the cut, and is that assumed when the engine is running at the required speed. Should the speed be accelerated, the raising of the balls would raise the sleeve and its pin, and thereby rotate the upper bevel wheel, turning in one direction the miter wheel with which it engages. If the speed fall below the medium, the pin on the sleeve falls and turns the other bevel wheel, moving the miter wheel in the other direction. The horizontal shaft of the miter wheel operates the throttle valve or gate of the pen stock.

c acts by substantially the same means through a system of levers upon a belt shifter. In the medium position the belt runs on a loose pulley ; but when the balls rise by acceleration of speed, or fall by retardation, the belt is shifted on to the upper or the lower pulley, which pulleys act upon the valve or gate requiring adjustment.

In *d*, instead of the arms being connected with a slide working on a spindle, they cross each other and are elongated upwardly, where they connect with the valve-rod by two short links.

Pickering's governor, *e*, has balls on springs, the upper ends of which are attached to a collar fixed on the spindle, and the lower end to a collar on the sliding sleeve. The springs bend outward proportionally to the centrifugal force of the balls, and thereby raise the sleeve, acting upon a rod which diminishes the area of induction steam opening. A diminution of speed has the contrary effect.

In *f* the balls ascend the parabolic arms as they fly outward when the motion of the engine is accelerated, and conversely. Anti-friction wheels assist the balls in the ascent. Rods from the axes of the rollers connect to a collar whose motions are communicated to a lever which acts upon the butterfly valve.

In *g* the upper ends of the ball arms have cogged sectors which act upon the racks on the axial rod to depress or raise it.

In *h* the oscillating weighted arm assumes a more horizontal position with increase of speed. Its normal or stationary position is shown in the illustration, its arms being out of poise.

i has balls upon toggle-arms, and resembles Fig. *e*, in which they are on springs.

In *j* the elbows of the arms are connected by a spring whose midlength is attached to a sleeve which slips on the spindle as the balls rise or fall.

k shows the connection of a governor similar to *a*, with the butterfly valve of a steam pipe ; and *l* is an illustration of a governor similar to *d*, but driven by a band wheel below.

Tyson's governor, *m m'*, 1861, has its arms suspended from a horizontal axis which rotates with the vertical spindle. He states that his object is to avoid "the friction which resists the free movement of the weighted arms in ordinary governors, and attain the desirable sensitiveness." *m* is an elevation, and *m'* a plan view looking upon the balls in motion, showing them swinging tangentially to a circle whose radius is equal to the length of the axis of suspension. When the engine starts, their inertia first comes into play, and increment of speed causes them to rise in the prescribed planes, the balls themselves describing an orbit of increasing radius. It is supposed to be more sensitive than the form in which the balls swing radially outward, but, like them, has the disadvantage of lateral pressure in its bearings, as the balls are compelled to rise in lines which are not the natural result of the forces which actuate them. In Tyson's the line of rise and fall is tangential to a circle of given radius ; in the ordinary governor it is directly radial.

In Shive's governor, *n n'*, the balls swing at an angle which is, as seen at *n'*, a compromise between the two last described. The axes of the mandrels on which the ball arms vibrate are tangential to the spindle, at a point distant about the semi-diameter of the ball from the axis of revolution of the vertical spindle. The balls thus swing outwardly and backwardly, so that the inertia as well as centrifugal action of the balls is brought into play. They are, however, compelled to rise in the prescribed direction, a compromise between the radial and the tangential.

Degener's governor, 1856, was designed to give to the pendulum balls "a motion independent of the motion of the spindle aside from their vibratory motion, by means of the diverging spiral inclines . . . . for the purpose of obtaining a more sensitive action of the pendulums." The collar from which the pendulums are swung is allowed to turn upon the spindle. The spirals are intended to "act under the pendulums and assist in throwing them upward" when the rate is increasing, or downward when the

speed is checked. The diverging spiral inclines are of a shape approximating the line of ascent and descent of the ball arms under increment and decrement of speed, and can only permit freedom of motion at one ratio of increase or decrease of speed. Freedom of motion is, however, not intended, but the inclines are intended to compel quick response.

In Knight's governor, Figs. *o*, *o'*, *o''*, *o'''*, the hinging axis of each ball arm has a capacity for adjustment in a plane at right angles to the axis of revolution, so that as the hinging axis permits the vertical motion of the ball, the adjustment in a horizontal plane of the bearing of the said hinging axis shall permit the outward swing of the ball, the two, in fact, forming a universal joint permitting the ball to follow the line of motion due to the speed and the proportions of the parts. In cases where the balls are compelled to rise in a certain plane, they can only do so with perfect freedom when running at one definite speed, and their motion on their hinging axes can never be perfectly free when running above or below the said definite rate; this fact is recognized by the introduction of the usual guides, as at *a b c d k l*, which prescribe the path of motion, and which would be unnecessary were the actions of the balls unconstrained. Any guide or immovable axis which tends to warp the balls from their true line of motion affects the freedom of their movements, entails additional friction, and intercepts or prevents their delicate and instant response to an acceleration or retardation of speed. If, upon an increase of speed, the arms or hinging joints of the balls have a tendency by a lateral strain or pressure to bind or rub, it is manifest that the balls cannot instantly respond, but that a cumulative force and speed will be required to obtain such a response as would more quickly result were the balls perfectly free to respond in their own way; and, in fact, the motion due to the inertia of the balls developed upon an accession of speed and manifested by their tendency to lag behind, is much more immediately responsive and active than the tendency to assume a more radial relative position which presently results. In this governor the balls are free to swing in such direction as may be induced by their speed and proportions, ascending or descending under changes of speed in such curves as may result from the combined forces of gravity and centrifugal impulse, under the condition of free pivotal attachment to bearings which are permitted to rotate in a horizontal plane.

Fig. *o* is an elevation of one mode of application of this principle, the balls swinging upward.

o' is a top view of the same.

o'' shows the balls at rest. *o'''* is another form, in which a spur or finger from above the hinging joint of the governor arm projects upward, and is jointed to a link pivoted above to a spindle in the plate; the finger and link together form a toggle, which brings the upper plate nearer to the lower one, the two ends of the toggle being hinged in bearings which are capable of horizontal rotation in the respective plates. The downward motion of the balls restores the normal position. The parts may be so arranged as to straighten the toggle by the raising of the ball, if so desired.

Modifications are shown in the patents whereby either the tangential or radial motions of the ball may be utilized, or an effect obtained from the sum of the two motions.

Some other forms than the pendulous ball may be referred to.

p is a governor in which the valve is operated by the direct pressure of steam upon a piston on its stem. The piston operates in a smaller cylinder, taking steam from the main cylinder.

q q' is Huntoon's hydraulic governor, in which a propeller wheel works in a liquid whose resistance causes a propeller shaft to rise in a degree proportioned to the rate of speed. The sectoral frame with its draw-pawls has a constant, reciprocating, rotary motion, and when either of the pawls comes in contact with the ratchet, it causes the ratchet shaft to rotate to actuate the steam valve. The rocker frame is actuated by the governor, and its cams bring one or other of the pawls in contact with the ratchet, according to the variation of the speed above or below the desired point.

r is a somewhat similar contrivance, in which the longitudinal position of the propeller in the water cylinder, due to its rate of speed, determines by the connecting rack and segment the position of the valve in the steam pipe.

Silver's momentum-wheel governor has a heavy revolving wheel, whose momentum acts upon the throttle valve when any change occurs in the rate of motion of the engine.

The hydraulic governor or cataract is the invention of Smeaton. A quantity of water is pumped at each stroke, and forced by counterweights through an orifice of a certain size.

Davis's governor (English) consists of a single hollow ball with a zone round it, having an opening through the bottom to admit of an upright spindle, attached to the ball by a joint in its centre. One side of the ball and zone is much heavier than the other, and consequently, when at rest or moving slowly, it hangs down; but when driven fast, the centrifugal force of the heavy side overcomes its gravity, and the zone assumes a nearly horizontal position. When this is the case, a small link inside the ball, jointed on one side of the axis, lowers the usual brass collar on the spindle, and shuts off part of the steam, till the diminishing speed allows the gravity of the zone to overcome the centrifugal force, and, the link being raised, the throttle valve is opened under to admit more steam.

In Mosman's chronometric governor, one of two shafts has rotation directly from the engine, its speed being relative to that of the engine. The other shaft has motion from the engine, but its speed is regulated by a pendulum or balance wheel. A variation in speed causes a longitudinal movement in the shaft which is connected to the governor valve.

—The Cincinnati Bridge Co. is building one combination bridge for the Cincinnati & Portsmouth narrow gauge road over the Litttle Miami River; also one wrought iron bridge for the Houston, East & West Texas Railroad, and a wrought iron bridge for Shelby county, Ohio. The company is getting out the iron for five bridges to be erected in Iowa and Kansas. It has contracted for the following work: Two bridges for Knox county, and one for Seneca county, Ohio, and one bridge for Mason county, West Virginia.

SCREW THREADS.

The modes which have been and are adopted of making screw threads in or on various solid substances, are more various than at first would be supposed; especially in working metals where there is a certain amount of flow among the particles, which is wanting in wood, ivory, and other organic solids. The general modes which have been used, in forming screw threads upon solid cylinders may be divided into chipping, filing, chasing, cutting, milling, indenting, jamming, forging, stamping, pressing, casting, twisting and coiling. The use of the file in screw making is not so crude as one might suppose; in fact, it has been practised for originating screws. Doubtless, in the earliest attempts, an inclined plane of paper was wrapped and cemented about an iron cylinder; the oblique line cut through by knife or knife-edged file, and the spiral enlarged by file until it became a screw in effect. Plumer recommends substantially this mode for cutting the thread upon a lathe-mandrel; the only difference being that the mandrel was mounted between centres, and a turning tool might be employed to assist. In the latter part of the last century, Anthony Robinson, of the Soho Works, Birmingham, made a screw 7 feet long, 6 inches diameter, and with a square triple thread, by turning the cylinder true, cutting a parellel-sided strip of paper as long as the cylinder and of a width exactly equal to the circumference,(so as to meet around it without lapping,) marking this paper with oblique and parallel lines of the proper pitch, to represent the margins of the threads; wrapping on the cylinder, pricking the outlines through with a centre punch, completing these spiral margin lines with a file, cutting out the spaces with a chisel and hammer, and filing the surfaces nearly smooth. This rough screw was placed vertically as a core in a metal tube, and pewter or gun-metal cast round it as a guide nut to receive adjustable cutters, which completed the screw on the cylinder being turned therein by levers. As a cold chisel was used in this operation, we have included chipping among the modes of screw-making.

Coiling two tinned iron wires on another, removing one of the coils, and dipping the others in melted tin, has been employed.

By making in a piece of board a groove sufficiently deep nearly to bury the rod to be threaded, and by making a second groove nearly at right angles with the first and sliding in this last groove a long knife-edged cutter, held at the proper angle, the rolling contact of the cutter carries the rod forward while indenting the screw thread.

We are familiar with those cases where the cylinder is revolved and a pointed turning tool (suitably shifted) scrapes away the spaces; or where the cylinder is revolved and a number of traversing pointed edges scrape away the spaces; as also with the converse of these two, where the V tool or the chaser is at rest and the mandrel has traverse. The chaser may have its cutting edges prolonged so as to partly enclose the cylinder, but not be wholly in contact circumferentially; in which case it becomes a cutting die. Where wholly in contact or the edges are not properly presented, it becomes a jamming die. If the action of many dies was considered we would say that the screw was rubbed out!

A milling-cutter or emery-wheel may take the place of the lathe tool and mill out the thread. Where a left-handed male screw is to be cut, a portion of a right-handed tap will cut it, or a portion of a right-handed screw used as a rotating tool will mill it out.

Wrought iron screws may be forged hot, between swedge tools having helical reverses like screw dies.

Screws may be formed by twisting rectangular bars as in making screw augers. Square threaded vise screws have been compressed cold, as with die-stocks—this means both indenting and squeezing or jamming. By passing a bar between suitable roller dies, the thread may be entirely jammed up.

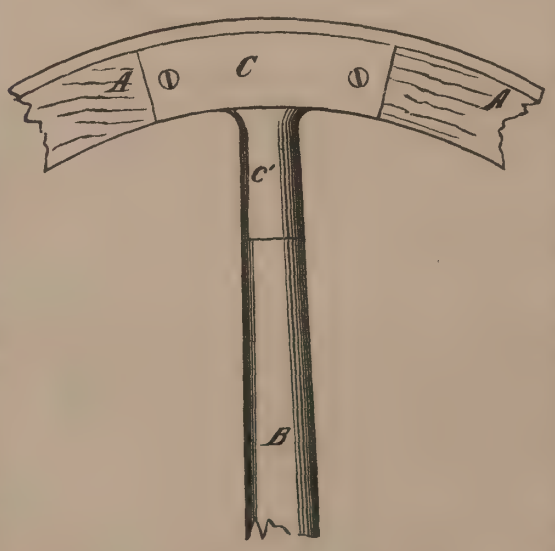
Casting threads is by no means an impracticable, nor is it at all a new mode. In 1839, Wilks made numbers of vise-screws and their boxes of malleable cast iron; making the mold for the mate, by screwing brass patterns into the sand and withdrawing them in the same way, (a brass guide-box lying on top of the mould aiding in tapping the sand and withdrawing accurately. The case for the female was made in a brass core-box and had a wooden caster to stiffen it and serve as a core-print. In 1841, Perkins cast (and patented) iron water pipes with screw joints. In 1842, Scott made "union joints," casting the pipe and socket at once, using two cores—one cylindrical, the other a fillet. The writer has made cheap brass hose couplings of large size, both male and female; the threads requiring but very little combing out. Of course, the large cast iron screws in screw piles are no curiosity.

In the manufacture of the collapsible tin tubes for artists' oil colors, the thread is made at the same time as the tube, in a fly press; the cold tin flowing perfectly. The screws in lamp tops are struck up from sheet brass. G.

IMPROVEMENT IN SPOKE SOCKETS.

Patented August 29th, 1876, by Henry Oldendorph, of Waterloo, Illinois.

The engraving is a side view of a part of a wheel to which this improvement has been applied. The object is to furnish a device for fastening a spoke that has broken off at the shoulder of the tenon, to prevent the spoke from wearing the felly and from rattling, and to prevent the spoke and felly from breaking, and which shall be simple in construction, easily applied to the wheel, and effective in use, holding the spoke securely and firmly in place.



The invention consists in plates provided with shanks, and so formed as to fit upon the side of a felly and spoke, to fasten said spoke when broken off at the shoulder of its tenon.

A represents the felly, and B the spoke of a vehicle wheel. C is a plate of such a shape and size as to fit upon the side of the felly, A, and which is provided with a shank, *c'*, which is so formed as to fit upon the side of the spoke, B.

The device, C *c'*, is cut out of sheet-iron, and is then struck up with dies to bring it to the proper shape. In using the device one of the plates, C *c'*, is applied to each side of the felly and spoke to be fastened, and is secured in place by screws or rivets.

The plates, C *c'*, are designed to be made of different sizes, so that they can be obtained to fit wheels of any size, and the owner of the vehicle can apply them for himself whenever needed.

—Nye & Palmer have now at work in the Gulch Mines, Black Hills, 18 of their steam vacuum pumps.

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

FELTING BOILERS AND PIPES.

The ordinary brick setting of a stationary boiler is the best means of preventing the radiation and conduction of heat, but in marine, locomotive and portable boilers it cannot be used at all, and for many other purposes there are also certain objections to it, so that boilers with *inside* flues and tubes have lately come into general use, thus dispensing with brick-work altogether.

They are generally lagged on the outside with felt, wood, or sheet iron; there are also innumerable compositions of plastic cements attached to boilers in different ways, for which the respective patentees claim immense savings.

M. Peclet, in his *Traité de la Chaleur*, has made some experiments on this subject, and by using some of his results and figures, the amount to be saved by any lagging may be found.

The heat which a body loses by radiation and conduction is directly proportional to its exposed area, and is also dependent upon the special properties of its surface and upon the difference of temperature between it and the medium surrounding it.

Mr. Peclet found that in cast or wrought iron tubes filled with steam, and surrounded by air of 59°, the condensation per square foot per hour would be 0·36 lbs.

Taking one of the boilers of the steamer Pennsylvania, which is 12 ft. 3 in. diameter, and 17 ft. long, the surface exposed would be about 750 sq. ft. If left uncovered, the condensation per hour would be $750 \times 0{\cdot}36 = 270$ lbs; the total evaporation for full power being about 9000 lbs. per hour, the loss would be $\frac{270 \times 100}{9000} = 3$ per cent.

The Galloway boilers at the Centennial Exhibion, illustrated in No. 9, vol. iii of this journal, had their top exposed to the width of 6 feet; being 28 feet long, their exposed surfaces would be 168 sq. ft., which would condense $0{\cdot}36 \times 168 = 61{\cdot}2$ lbs. of steam per hour. Supposing the entire evaporation to be about 2500 lbs. per hour, the loss would be $\frac{61{\cdot}2 \times 100}{2500} = 2{\cdot}448$ per cent.

To find the loss of heat from bodies surrounded with layers of different substances, that are but indifferent conductors of heat, Mr. Peclet uses the following formula:

$$q = \frac{T' - T}{C + \rho\, x}.$$

Where q is the rate of conduction per sq. ft. per hour, in units of heat, T' the inside and T the outside temperature; C is called the coefficient of external thermal resistance, ρ is the coefficient of internal thermal resistance, and x the thickness of the covering material. The coefficient C depends on the nature of the substances and their surfaces, and on the difference of temperatures, and will, for steam boilers, pipes, etc., be about $= 0{\cdot}75$.

The coefficient ρ (when x is given in inches) is for

Copper	0·0040	Gypsum	0·57
Iron	0·0096	Oak	1·093
Lead	0·0198	Fir, with the fibres	1·613
Marble	0·0873	" across "	3·04
Brick	0·4020	Wood ashes	4·55
Felt	6·5	Linen	5·486
		Paper, gray, unglued	9·13

One of the most recent coverings for boilers, pipes, etc., is a species of combination felting; the inner layer next to the boiler consists of a plastic cement, over this a layer of hair felt is put, held on by wire netting, and the outer layer is again plastic cement, which, when finished, is painted to exclude moisture.

If our first example were to be covered with this material, say 3 inches thick, of which 1 in. would be felt, 1 in. plastic cement, inside, and 1 in. outside, then the internal thermal resistance would be

$= \Sigma\, \rho\, x$ or $\left(\begin{matrix}\rho \text{ for felt being} = 6{\cdot}5 \\ \text{for gypsum} = 0{\cdot}57\end{matrix}\right)(6{\cdot}5 \times 1) + (0{\cdot}57 \times 2) = 7{\cdot}64$, and the rate of conduction:

$$q = \frac{T' - T}{U + \Sigma\, \rho\, x} = \frac{248}{0{\cdot}75 + 7{\cdot}64} = 29{\cdot}56, \text{ and the total loss by conduction:}$$

$$= 29{\cdot}56 \times 750 = 22170.$$

The latent heat of steam at 60 lbs. pressure being about 900°, this loss would equal the condensation of $\frac{21170}{900} = 24{\cdot}93$ lbs. of steam, or $\frac{24{\cdot}93 \times 100}{9000} = 0{\cdot}277$ per cent., showing a gain of $3 - 0{\cdot}277 = 2{\cdot}723$ per cent.

If in the second example the exposed surface were covered by a brick wall 12 in. thick, the loss by conduction would be

$$168 \times \frac{248}{0{\cdot}75 + (0{\cdot}402 \times 12)} = 7474,$$ equal to a condensation of $\frac{7474}{900} = 8{\cdot}3$ lbs. of steam, or $\frac{8{\cdot}3 \times 100}{2500} = 0{\cdot}332$ per cent., showing a gain of $2{\cdot}448 - 0.332 = 2{\cdot}116$ per cent.

In other cases, as where the boiler is exposed to draughts, or in locomotives, or portable engines, where it has to bear all the inclemencies of the weather, the loss is certainly much greater, and the lagging becomes more valuable in proportion.

The condensation in steam pipes may reasonably be supposed to follow the same laws as in boilers.

If the steam in the first mentioned boiler is carried away in a $9\frac{1}{2}$-in. pipe, the exposed surface for each 100 feet length will be $2\frac{1}{2} \times 100 = 250$ sq. ft., and the condensation $0{\cdot}36 \times 250 = 90$ lbs. per hour, or $\frac{90 \times 100}{9000} = 1$ per cent.

In the Galloway boiler, the steam-pipe being 5 in. diameter, the exposed surface for 100 feet length will be $1\frac{1}{3} \times 100 = 133$ sq. ft., the condensation $0{\cdot}36 \times 133 = 47{\cdot}88$ lbs., or $\frac{47{\cdot}88 \times 100}{2500} = 1{\cdot}9$ per cent.

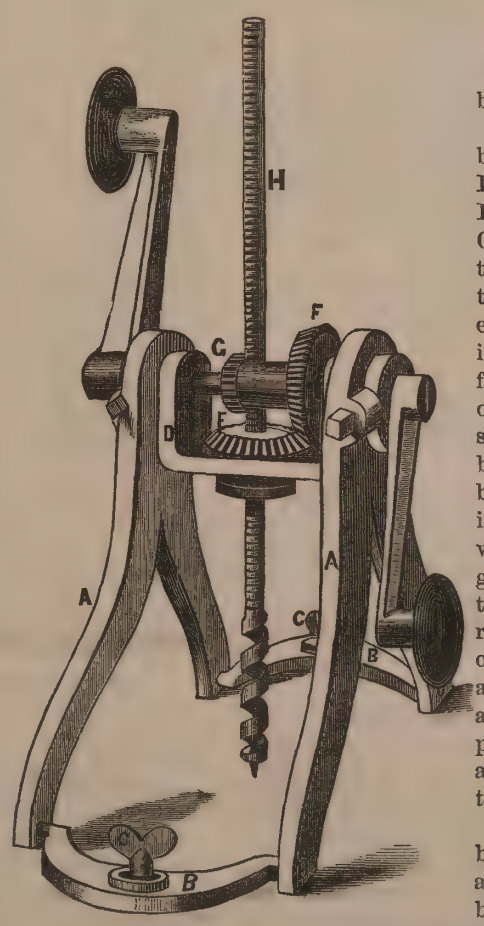
When a boiler is worked at half power, the condensation will remain the same, but the *percentage* of loss will of course be doubled.

The water from this condensed steam, if it were drawn off by a steam trap, or separator, would still retain the temperature of the steam (307° for 60 lbs. pressure), and might thus be advantageously used with the feed; but if any of it is retained in the steam, and conducted with it into the steam cylinder, it will seriously deteriorate the efficiency of the steam by inducing an extensive variation of temperatures in the metal of the cylinder, valve chest, piston, etc.

The effect of this will be treated under the head of "Steam Jacketing" etc., in a future article.

J. HAUG, M. E.

IMPROVEMENT IN WOOD-BORING MACHINES.*



The object is to construct a machine to bore at any angle, or at any depth.

A A are the supports; B B the reversible fastenings; CC the fastening screws; D trunnions connected with gear support; E the driving shaft; F the driving gear; G lifting pinion; H the auger shaft; K the angle indicator, provided with a threaded socket. The machine is fastened to the material to be bored, by passing the screws. C, through the reversible fastenings, B, into said material. A bit of the requisite size is screwed into the socket of the auger-shaft. The auger or bit is placed against the material to be bored at the angle required. The crank is then turned and the hole bored. To withdraw the auger or bit, the driving gear is thrown out of gear, which brings the lifting pinion, G, into gear with a rack upon the auger shaft. The motion of the crank is reversed, and the bit or auger is withdrawn from the hole. The auger shaft is caused to turn by a key placed in the driving gear and fitting in a slot in the shaft, permitting said shaft to slide upon it.

To bore a hole deeper than can be bored by the auger-shaft represented, attach a similar shaft to the one shown, by screwing it into the top of it.

A new industry pursued at the shop of the Nashua Iron and Steel Company at Nashua, N. H., consists of the manufacture of S. A. Woodbury's patent car wheels, the inside or frame of which is cast from gun metal, and the outside is a heavy steel tire, hardened tread.

* Patented November 7th, 1876, by George S. Derr, of South Bend, Indiana.

Fig. 1.

Fig. 2.

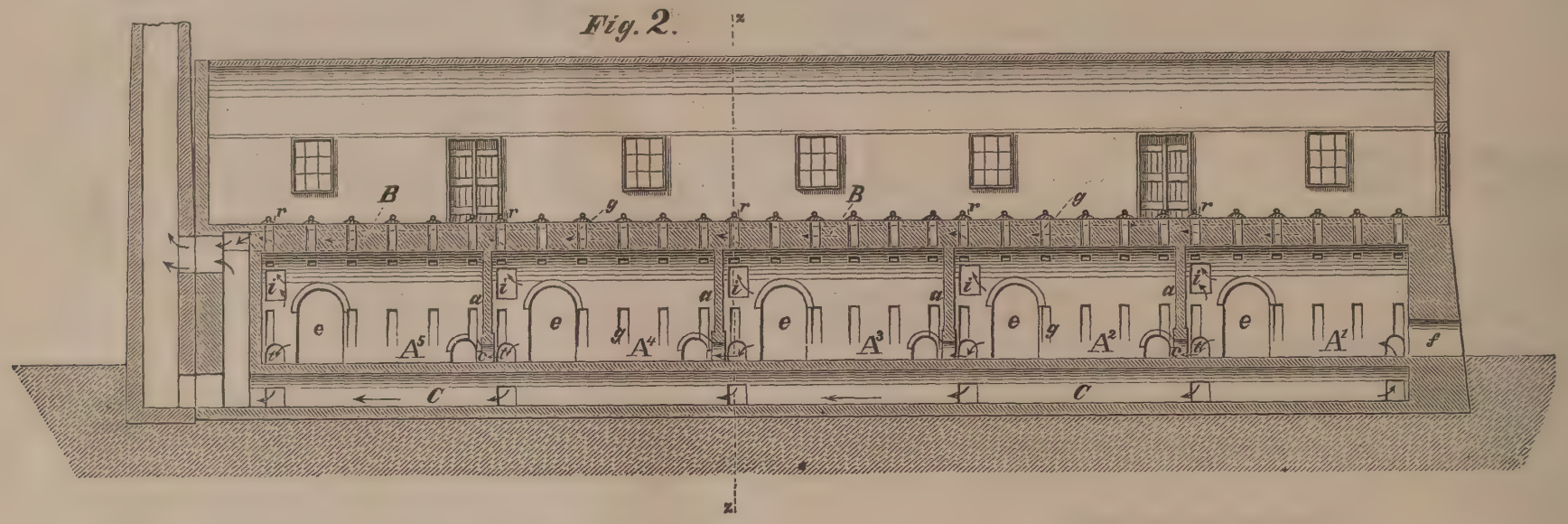


Fig. 3.

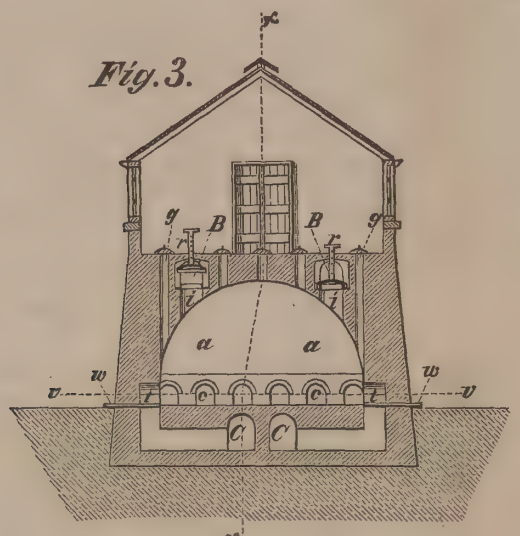


Fig. 4.

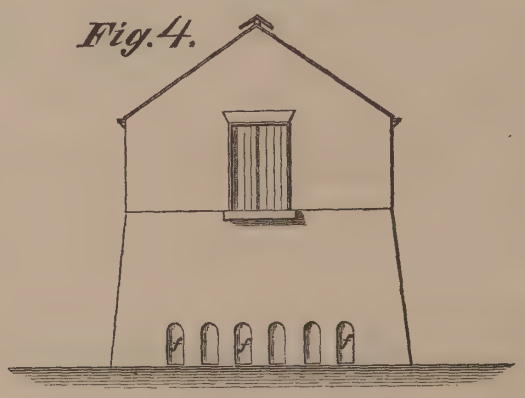
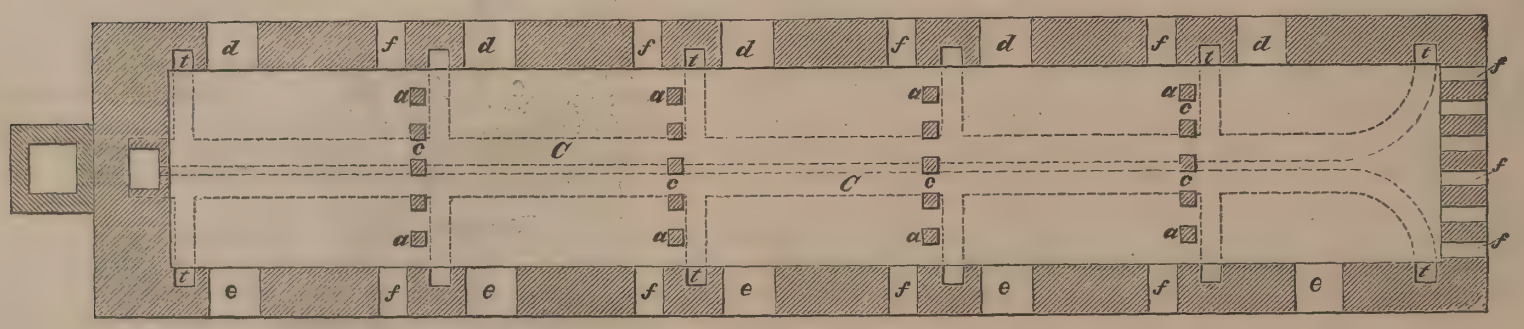


Fig. 5.



BRICKS AND BRICK MAKING.—XX.

THE MORAND KILN.

The following is taken from the *American Artisan:*

DESCRIPTION OF THE MORAND KILN AND MODE OF WORKING IT.

The kiln is constructed with a series of separate drying and burning chambers, separated by walls having draught-openings through them at the bottom, and it consists in the chambers being constructed with fire-places and (in the case of straight kilns) hot-air flues at one end, and with openings in the upper part of the opposite end, the upper openings being connected on either side by horizontal flues leading to the chimney, and the lower hot-air flues (used with a straight kiln) connected with each other on either side by the bottom flues, constructed under the kiln from end to end, the object being to facilitate the drying and burning of bricks by first driving off the superabundant moisture therefrom directly through the upper openings in each chamber; then, by closing the upper apertures, and opening the lower draught apertures in the division wall, to carry the surplus heat from the one kiln directly into the bottom of the next, or through the bottom of the flues to any other chamber of the kiln, as may be desired.

In the accompanying engraving Fig. 1 is a side elevation. Fig. 2 is a longitudinal section taken on the dotted line, *x*, *x*, of Fig. 3. Fig. 3 is a transverse section on line, *z*, *z*, of Fig. 2. Fig. 4 is an end elevation. Fig. 5 is a sectional plan showing the horizontal bottom flues in dotted lines.

A^1, A^2, A^3, A^4, A^5, are the drying and burning chambers of the kiln, which are preferably built in a right line with each other, as shown in the drawing. The chambers are enclosed by strong, well-built outer walls, and are arched over, as illustrated in Fig. 3. They are lined with suitable bricks, and separated from each other by partition walls, *a*. Air-holes, c, are left in the partition walls to be opened or closed at pleasure, in the operations of the kiln. Each chamber is provided also with outer doorways, *d* and *e*, arranged on either side, as convenience may suggest, for the reception therein of unburned bricks, and the delivery of the finished bricks therefrom, and which are likewise closed in the customary manner by means of temporary walls of brick. Fireplaces, *f*, *f*, are constructed on each side of the kiln, at one end of each chamber, preferably in the two corners, as illustrated in the drawing, excepting in

chamber A^1, where they are preferably constructed in the front end, as also shown in the same drawing. Stoke-holes, *g*, *g*, are formed systematically through the arched roof of each chamber to supply fuel thereto at the proper time. (See Figs. 2 and 3.)

B, B are horizontal steam and smoke draught-flues, formed longitudinally on either side of the kiln to extend from end to end thereof over the arch forming the roof of the chambers. Openings or passages, *i*, *i*, are formed on each side of the kiln, through the top of each chamber, by preference at that end remote from its fireplaces, *f*, *f*, so as to communicate with flues B, B, as shown in Fig. 2 and 3 of the drawing. Dampers, *r*, *r*, are arranged to control the openings *i*, *i*, and the upper longitudinal flues B, B, in front of the openings *i*, *i*, as shown in Figs. 2 and 3. C, C (see Figs. 2, 3 and 5) are longitudinal hot-air flues constructed under the floor of the kiln, to extend from end to end beneath the entire series of chambers. Branch flues or passages extend from these longitudinal flues to openings, *t*, *t*, in the corners of the chambers. These openings or branch flues in the first chamber adjoin the fireplaces at the front end, but in the remainder they are placed remote from the fireplaces, as shown in Fig. 3, and by dotted lines in Figs. 2, 3 and 5. These openings are closed at pleasure by horizontal dampers, *w*, *w*. The upper longitudinal hot-air flues, B, B, and the lower longitudinal hot-air flues, C, C, both open into a common chimney at the end of the kiln; but their communication therewith is controlled at pleasure by suitable dampers. Instead of constructing the flues centrally under the kiln, they may be constructed on either side thereof, or, in fact, although two are preferable, a simple longitudinal flue may be used. The draught-flues, B, B, and bottom flues, C, C, being both in communication with the chimney or chimneys, and with each of the chambers, form, in connection and combination, a continuous passage or channel over and under the kiln from end to end, or through any one or more of the burning-chambers, through which draughts or currents of air may be passed, the direction of the draught or current being determined by the dampers.

The operation of the kiln is as follows: The chambers, A^1, A^2, etc., being filled with green bricks or other articles for drying and burning, and the doorways, communicating openings, and stoke-holes being closed, fires are built in the fireplaces, *f*, *f*, *f*, of the first chamber, A^1, the openings, *i*, *i*, into the upper longitudinal flues, B, B, are unclosed, and the openings into the lower flues, *t*, *t*, are closed by means of their proper dampers. As the bricks gradually become heated and give off their steam or vapor in drying, this vapor is at once carried off through the flues, B, B, and from the position and peculiar arrangement of the opening into said flues on either side of the crown of the arch, the moisture is carried off from all parts of the chamber uniformly, commencing at the bottom and front end. The bricks at any one point are thus prevented from becoming or remaining unduly moist after the remainder have dried; the lowermost tiers, which are subjected to the greatest pressure, being the first to dry and harden. When the bricks or other articles in the first chamber, A^1, are sufficiently dried, instead of wasting the heat therein by continuing the draught directly with the chimney through the upper flues, B, the passages, *i*, *i*, A^2, communicating with said flues, are opened, and the passages, *i*, *i*, in A^1, nearly closed. The surplus heat necessarily obtained in finishing the burning is thus utilized in drying and burning the fresh charge of bricks in the adjacent chamber, A^2. Thus the surplus heat from one chamber in the series is utilized in the operation of the next, until the last chamber, A^5, is reached. When the bricks or other articles in this chamber, A^5, are sufficiently dried, the dampers in the passages leading therefrom to the bottom flues, C, C, are opened; and the communication of said flues with the chimney and with all intermediate chambers being also closed, the surplus heat (in the case of straight kilns) may be conveyed back to the first chamber, A^1, to be there utilized in drying the fresh charge of brick or other articles in the meantime placed therein; or, as above set forth, by a proper arrangement of the dampers, may be conveyed to any other of the drying and burning chambers which may be charged with brick ready for drying and burning.

It will be observed that in the use of the bottom flues, C, C, and their branches communicating with the several drying and burning chambers to convey the surplus heat from one chamber to another, the necessary draught in and through each chamber required to produce a draught or current thereinto from the bottom flues, C, C, is obtained by means of the upper flues, B, B, connected with the chimney or chimneys, and opening into the upper part of each chamber, as set forth.

Thus, by means of the special construction and arrangement of the upper and lower flues, B and C, controlled by dampers, as described, and communicating with each other through each chamber by suitable passages or openings thereinto from the one and the other, the drying, burning and cooling of bricks or other articles in each successive chamber of the kiln may be conducted continuously, regularly and expeditiously, with very great economy of fuel; and in case it is found necessary to discontinue the operation in any one or more of the chambers of the series, the connection with such chambers may be closed, and yet the operations in other chambers be carried on without interruption, and still economizing in the utilization of the surplus heat.

G.

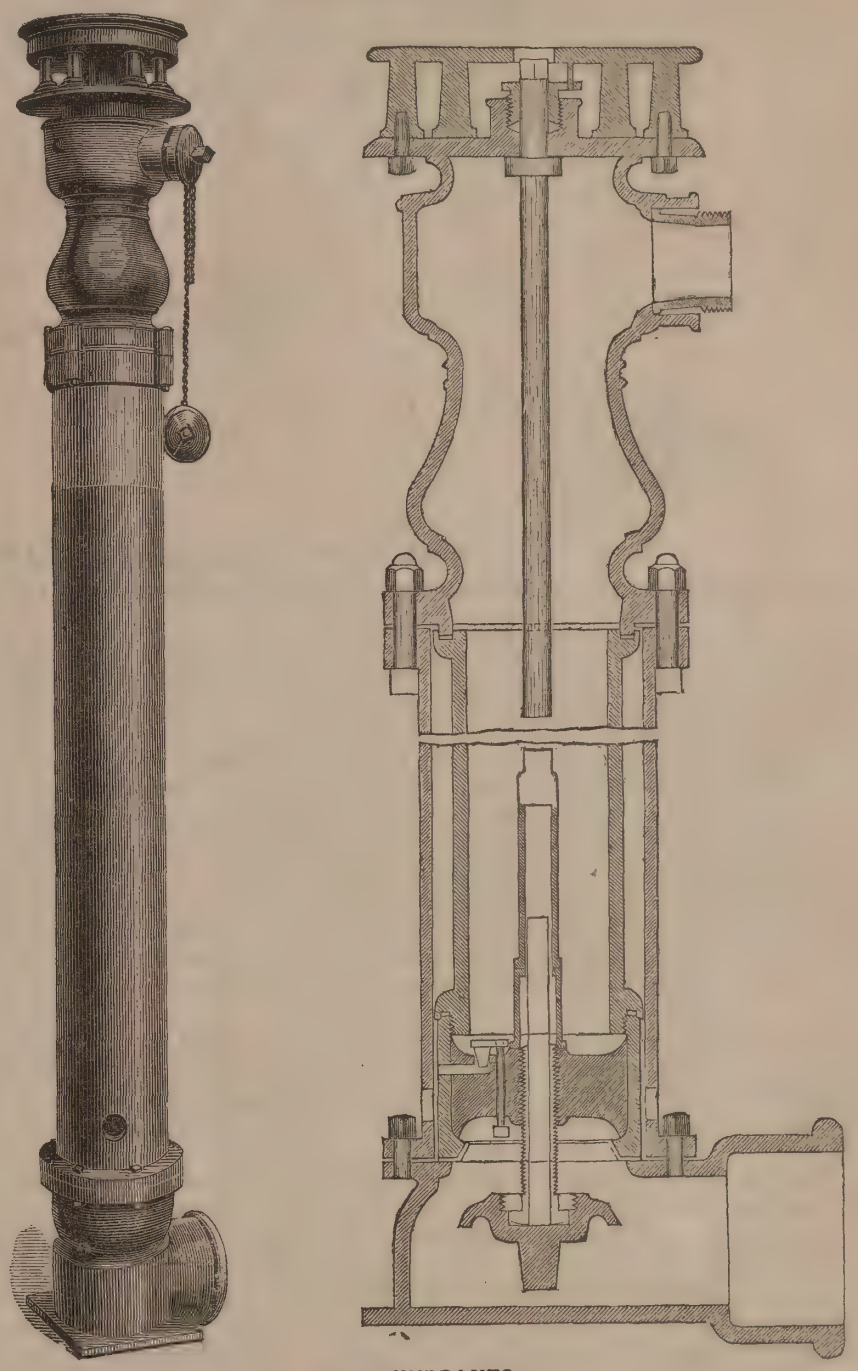
[To be continued.]

THE WEAR OF STREET RAILS.

It is a curious fact that by the most casual glance at a street-railway track, one who has noted the manner of its wear, can tell from that alone the direction in which the cars run thereon.—whether "up" or "down" or both. On the north-bound track the south end of the rail is most worn, and vice versa. The reason for this is that the imperfect fish-joint used where indeed any chain or stiffener is used—the weight of the car on the north-bound rack depresses the north end of the rail, lifting the south end, and partly drawing the spike therein; and the wheels strike full and hard against the south end of the next rail, (raised by the passage of the previous car) and tend to round the head and to split the flange vertically; a result which is not long in showing itself. The middle spikes are hardly ever drawn at all; those in the ends are loose, and may be easily drawn—as one might expect from their being partly drawn and redriven from twenty to sixty times an hour. Another instance of wear is noted on the inside edge of the head, where metal is worn off by the grinding of the car wheel flange; and by the lashing out of the horses' hoofs endeavoring to get a foot-hold on the rail-flange in starting. The grinding action of the tires of vehicles endeavoring to turn off the track, shows itself also on the inner edge of the rail head; and points to the demand for such a section as will enable a carriage-wheel to mount the head at once and get off the track. A somewhat greater inclination on the inside of the rail-head would permit this for an unflanged wheel only, while doing away largely with that skidding of the wheel and wrenching of the axle, and it would, while saving rails, enable the track to be cleared quicker than at present.

Slight transverse depressions in the flanges of the rail, at such distance from the head as to leave a level strip nearly as wide as the tread of a car wheel, would give the horses some hold for their toe-calks in starting, and thus diminish the wear of flange and inside head, caused by their feet slipping; would save time in starting and be easier on the horses' joints, would enable carriage-wheels on being skewed across the track for the purpose of turning out, to get a grip on the flange, that would prevent skidding and consequent wear of flange and inside rail-head; and would prevent wrenching of carriage axles, grinding of tires, battering of felloes, and give comfort to occupants. Where, however, carriages have to turn out of a track, on to that disgrace to modern civilization a cobble stone pavement, the wrenching, grinding, battering and discomfort on the cobbles, would at once be so multiplied, prolonged, and intensified to the music as of a quartette of trip-hammers, that we might leave them out of the question. If it were not a bull of finest breed and largest size, we would say "Down with the present rails and the present cobbles."

G.



FIRE HYDRANTS.

HOLLY'S PATENT FIRE HYDRANT.

"The cut represents the exterior and sectional views of Holly's fire hydrant. The outer case is set in the ground at the required depth, and to which the earth will freeze so as to adhere in severe weather. It has also an inner stem through which water is forced for fire or other purposes. Between the case and stem is a space for air. The valve is at the bottom of the case, and so far underground as to be entirely out of reach of frost, and is operated upon by a valve rod, the screw and nut of which are immediately above the valve, and so secured as to prevent any vibration under very heavy pressure. The valve-seat is of leather, and the valves open against and close with the current. In order to get at the valve, take out the four bolts at the surface of the ground, the inner stem with valve, and the whole working part of the hydrant can then be taken out, examined or repacked and replaced without difficulty, making the joint at the bottom of the stem tight by tightening the four bolts at the surface of the ground. It is so arranged that when the valve is closed all the water in the case above the valve will run out, leaving the hydrant empty at all times except in case of fire or when water is rapidly passing through it; and as the valve is so constructed that it will not leak one drop, it is impossible for frost ever to affect this hydrant. The act of opening the valve closes the drip and prevents any water escaping while the hydrant is being used. A guard at the top prevents any unauthorized persons using them, as they cannot be opened except with a lock-wrench constructed especially for this purpose. The makers state that no case has been reported where one of these hydrants has frozen, and they have been placed under pressure equal to five hundred feet head without leaking. Manufactured by the Holly Manufacturing Company, Lockport, N. Y."

Fig. 1.

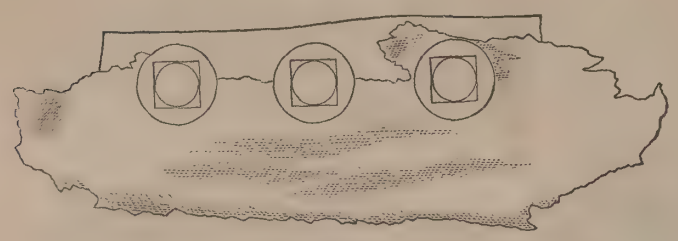


Fig. 2.

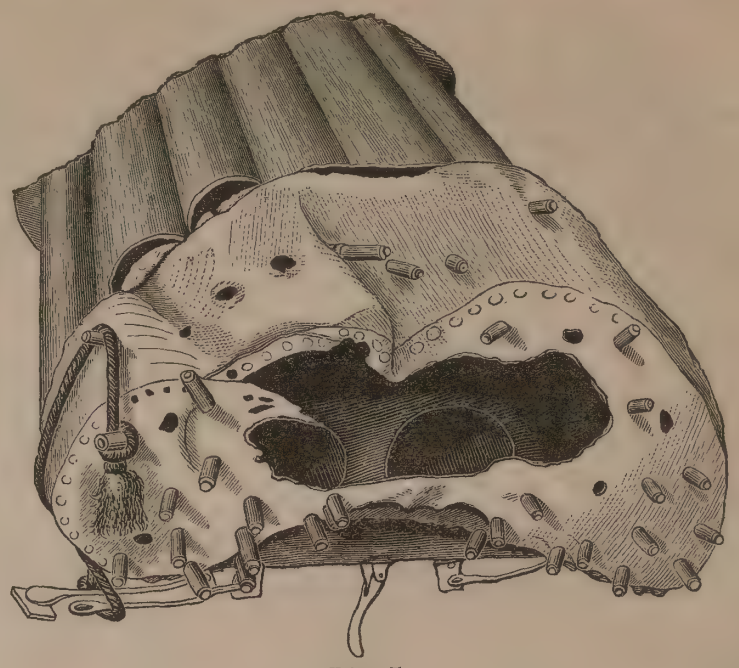


Fig. 5.

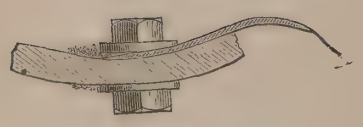


Fig 3.

Fig. 4.

ANNUAL REPORT OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

TO THE DIRECTORS OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY:

Gentlemen:—In laying before you an account of the proceedings of this company for the year 1876, together with some views relative to the causes of boiler explosions, as derived from greater experience, it is gratifying to state that there has been a growing appreciation of our work and of its importance. The general depression in business, however, throughout the country has affected all departments of manufacturing. But notwithstanding this, the company has made more inspections than in any one previous year. The number of inspections, external and internal, made during the year was something over 40,000. The number of defects discovered, which were regarded as dangerous, and verging on danger, was 4,275. There were numerous other defects to which attention was called in the written report, of the inspections made to the assured. These minor defects are liable to occur in connection with the best of boilers. Some flaw in the iron, which was not discovered by the builder of the boiler, is developed by the varying temperatures to which the boiler is subjected in use.

Minor defects appear very harmless at first, and in reality may be so, but if neglected month after month, and year after year, ruin may follow. A small stream, trickling through the embankment of a reservoir, may appear harmless, but if it is neglected, the destruction of all the property in the valley below may be the consequence.

When a weak or corroded spot is found in a boiler, it should be carefully examined with reference to the best means of repairing. If the sheet is found corroded so thin that there is not strength enough to hold the rivets necessary in patching, the sheet should be entirely removed and a new one substituted. Or, if the defective spot is confined to only a portion of the sheet, the iron should be cut away until sound metal is reached, and the patch should be riveted thoroughly to the sound portions of the sheet, and the edges of the patch caulked. In their anxiety to avoid delay and expense, steam users sometimes put on what is called a "soft patch." This consists of a piece of iron laid over the defective spot, and held in place by bolts, making the joint tight with stiff putty, composed of white and red lead and a small quantity of fine iron borings. This method of patching is careless, often in the extreme. The bolts are held only by a thin portion of corroded sheet, and are liable to tear out at any time. Soft patches over fractures where the bolts are held firmly by sound iron are not so bad. Still the method, at its best, is not one which we would recommend. To illustrate the method of patching corroded boilers, as described above, attention is called to the following case. We were called to examine a boiler, and found it had been patched at various times by bolting pieces of iron over the corroded part. One of these instances was so marked that it was cut out, and is preserved in our collection in this office. Figs. 1, 2, and 3 show it from different points of view.

The rectangular piece is the patch of sound iron one-fourth inch thick, held in place by three bolts. The irregular piece to which it is attached shows the broken edge of the corroded spot.

Fig. 2 shows the inner surface of the sheet, and how little metal there was to hold the bolts in place.

Fig. 3 is an end view of this piece of workmanship. The reader will notice the difference in thickness of the patch and the plate to which it is bolted. This is something like "*putting new cloth into an old garment.*" There are a great many boilers in the country running to-day, patched as above described, and in many instances, no doubt, with equally careless workmanship; and yet it is only within a very short time that *some* people have begun to believe that boiler explosions are not always "mysterious providences."

We have found during the year 1,026 cases of *external corrosion*, 442 of which were regarded as dangerous; also 542 cases of *internal corrosion*, 131 of which were regarded as dangerous. The causes of these defects are various. Where boilers are bricked in, leaks occurring up near the water line are not easily discovered, and corrosion may go on insidiously until the sheet is largely worn away. This defect in its early stages, can only be discovered by careful inspection when the boiler is cold.

The inspector must make a careful examination externally, underneath, and if he discovers indications of corrosion, the brick wall should be removed and the boiler be very carefully examined at the point where the leak is supposed to be. We have found cases where the boiler was so badly corroded that the steam was kept in place mainly by the brick wall. This is not a very reliable method of confining steam under 60 or 80 pounds pressure.

In iron and coal mines, and iron works, were boilers are frequently used with no covering over them, external corrosion is not uncommon. It is, however, a very dangerous way to deal with boilers, and probably accounts for many of the accidents which occur in such places. *Internal corrosion* occurs from a different cause, usually from some impurity in the water. An interesting case came under our notice. We were called to examine the boilers of a tallow manufactory, which were supposed to be in fair condition, and were running at a pressure of sixty lbs. to the square inch. An internal examination revealed the fact that the feed-water was contaminated with the refuse of the works, and that internal corrosion was doing a dangerous work. The water was examined and found to be strongly impregnated with stearic acid. The condition of the boiler was such that it was condemned as unfit for use. The braces and stays were so corroded as to be of no use whatever. Fig. 4 will show the condition of the braces, several of which can be seen in this office.

Here was a boiler supposed to be in safe condition, yet it was liable to give out at any moment, and cause great destruction. A careful inspection doubtless prevented such an accident. An instance of *external corrosion* occurred in a neighboring State. The boiler was corroded to the thinness of sheet iron, at the point where it rested on a brick wall. The boiler had never been under our care, and so far as we could learn had not been inspected for some years.

The boiler exploded, causing great destruction. Portions of it were carried hundreds of feet away. Buildings were damaged and blown down, and one or two persons were killed and others injured. I am of the opinion that a timely and careful inspection would have discovered this defect and prevented the accident. Fig. 5 shows a portion of the boiler as it was found some distance from the scene of the accident.

(*To be continued.*)

METAL BEARINGS.

If we were asked to sum up the requirements of a bearing, we should doubtless lay down that it must be as hard as steel, to resist pressure and wear; and also as soft as lead, so as not to cut the journal, but to bed up and fill out any roughness in the latter, while also permitting grit to sink out of the way so as not to cut. It must also be as smooth as glass, to lessen friction, but at the same time it should be rather roughish, in order to retain in its depressions a portion of whatever lubricant is used. If the bearing can be as cold as ice, so as to cool the journal, and if at the same time it can be what ice is not—an excellent conductor of heat—so much the better. All these

points being met, the bearing will very nearly fill the bill; but one very important consideration—that of cost—must not be forgotten. It does really seem, however, as though, if all the other requirements were met, this last might be foregone.

If two rubbing bodies are of different hardness, the production of heat is less, the greater the difference between their hardness, and for equal volumes, the softer is less heated than the harder.

Referring to axle bearings alone as a type of severe requirements, we find usage among railways very different, some preferring to economize in bearings ("brasses") at the expense of axles and lubricants, and using from 17 to 20 per cent. tin and 83 to 80 copper.* Other companies use lead and antimony bearings, which wear out fast and need a great deal of lubricant. Where refuge is taken in "white-metal" (copper, antimony and tin), it is difficult to make this alloy hard enough to approximate the axle in this respect, without its being brittle. The ordinary white-metal will run out with comparatively little heat, and leave the axle to deal with the skeleton bearing and axle-box, causing cutting and scoring. These difficulties make themselves particularly felt on our American roads, where a bearing is likely to be run thousands of miles on other roads than its own, and is, in consequence, liable to be overlooked and unattended.

The soft-metal bearings present the apparent advantage of being readily replaced, but develop the requirement of being frequently replaced, and hence the facility of replacement is only a palliative.

Where we employ gun-metal (tin and copper), we generally meet this trouble—that, if cooled slowly, the tin separates and appears in spots. 17 to 18 per cent. of tin and 83 to 82 of copper is the most trustworthy of these alloys as regards homogeneity when cooled slowly. Alloys from 12 to 17 of tin, 88 to 83 copper, segregate as mentioned unless chill-cast, which is impracticable. This heterogeneity causes "gripping," and hence rapid wear. Its cause is this—that softer metal (say 9 to 10 tin, 93 to 90 copper) sets first, and forms a soft skeleton; the remainder, or hard and brittle alloy (of say 17 to 18 tin, 83 to 82 copper), sets later, and fills the pores of the soft skeleton. The harder metal is apt to be torn away in flakes unless the bearing is kept very well lubricated.†

The reverse condition is what is desired—a hard skeleton and soft filling. The skeleton of a bearing should approach the journal in hardness, and should resist shock and pressure. The filling should be soft and ductile. Künzel made bearings of gray pig-iron 85 and lead 15; but the iron was too hard and scratched the journals, and the skeleton did not resist even weak shock and pressure.

The phenomenon of segregation, which is such a nuisance to the gun-founder, proves of the highest advantage in casting bearings, when the skeleton is the harder of the two alloys. It simulates perfectly, but improves upon, the practice of the marine engineer in casting a hard gun-metal cage to resist crushing and distortion, and filling up afterwards with a softer alloy.

So far, but one alloy seems to fill the bill properly as regards bearings, and that is one of the phosphor bronzes; alloys which have shown themselves to possess the most remarkable tensile strength, freedom from corrosion, and anti-friction qualities. It can be so proportioned as to segregate into a sponge-like skeleton or cage of very hard but not cutting alloy, filled with a softer metal, whiter in color, and which may, indeed, be melted out of its cage by exposure to a fire, leaving the bond or skeleton as a hard and porous mass, unchanged from the original form.

The table gives results tabulated by Dr. Charles Künzel in the *Polytechnisches Centralblatt*, and translated by *Engineering*, xvii, 466 (June 26, 1874):

Kind of Bearing.	Comp. per 100 parts of alloy.	Cost per 100 kilos of bearings (including cost of casting, and loss).	German Miles.	Kilometers.	Wear per 1000 kilometers for four bearings, in grammes.	Cost of Bearing per 1000 kiloms. and per car with 4 bearings, Eng. pence.	Railroads.
Gun Metal	83 cop. 17 tin	260.2	12,052	90,390	11.60	0.301	Austrian.
do.	82 " 18 "	260.8	13,320	99,900	10.01	.260	Grand Cent. Belge
do. on Brake Cars	82 " 18 "	260.8	1,218	9,134	109.48	.2844	do. do.
White Metal	3 cop. 90 tin, 7 ant.	293.68	9,104	78,280	14.64	.395	Austrian.
do.	5 " 85 " 10 "	293.40	11,750	88,145	11.35	.331	Niederschles-ische-Markische
Lead Comp.	84 lead, 16 ant.	118.56	10,338	81,280	12.30	.145	Austrian.
Phosphor Bronze		350	57,226	429,200	2.33	.081	Grand Central
do. on Brake Cars		350	14,320	107,410	9.31	.325	Belge.

The following statistics give some of the results of tests upon the Great Northern Railway, England, with different metal bearings:

	Distance run to wear away 1 lb. (miles).	Weight of metal worn away in 100,000 miles (pounds).
Gun Metal	15,364	6.51
White Metal	24,840	4.02
Phosphor Bronze	75,613	1.32
Parsons' White Metal	67,885	1.48

G.

—The Wood & Light Machine Company, Worcester, Mass., have recently shipped one of their patent shafting lathes to a large house in Prussia.

—The silver mines in Mason county, Texas, are said to be getting richer the more they are worked, and are now paying handsomely.

—An immense deposit of "black lead" has been discovered near Warren, Va.

*18 per cent. of tin, 82 copper, might more properly be classed as "bell-metal."

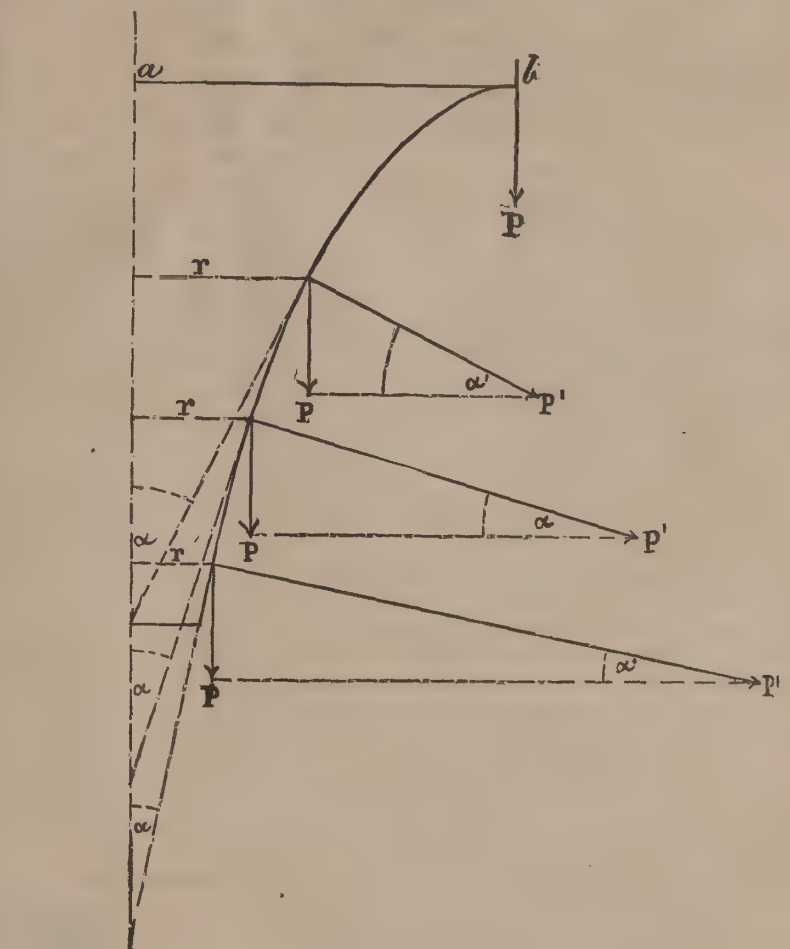
† With homogeneous gun (bell) metal, a neglected hot axle will braze to the bearing and twist off the journal.

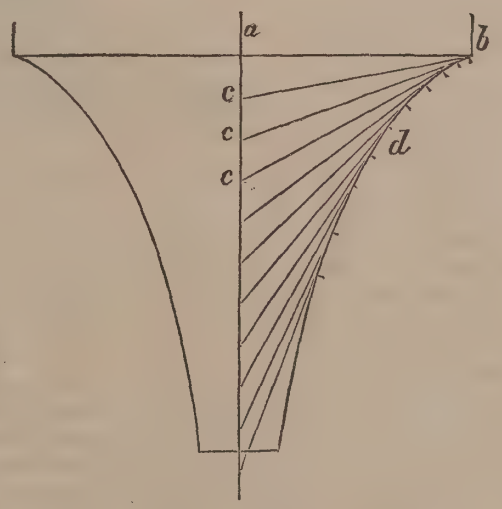
SCHIELE'S CURVE.

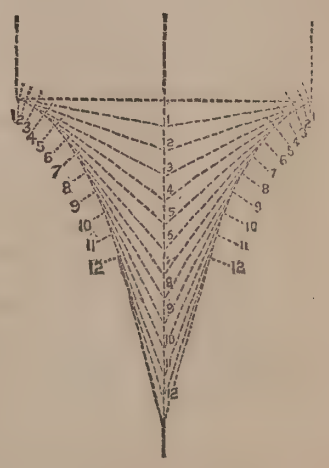
This is also called the anti-friction curve, although it does not really diminish friction directly, but only indirectly, in securing a uniform wear on the entire surface, while a flat, conical, or rounded pivot will always wear more at its outer circumference, the velocity being greater at that point.

The work done by friction may be found by multiplying the total pressure upon the surface by the coefficient of friction, and by the velocity of motion. In a rotating body that velocity varies as the radius, and thus the work is greatest at the greatest radius, causing there the greatest wear.

By constructing a pivot with Schiele's curve, the pressure (at right angles) to the surface is increased in the same proportion as the radius decreases, and thus the work of friction and consequent wear is kept uniform.







This curve is constructed by the radius $a\,b$ being placed in the successive positions 1 1 (its inner end being in the centre line at 1, and the outer in the line $a\,b$), 2 2 (the inner end in the centre at 2, the outer in line 1 1), 3 3, etc., and the radius $a\,b$ thus is a tangent of equal length to every point of the curve; the pressure at right angles to the surface being at right angles to the tangent, will have the same proportion to the vertical pressure (which of course is uniform), as the *tangent* has to the *radius* at every point. Thus at $a\,b$, where the radius is equal to the tangent, the pressures are also equal; where the radius is $\frac{1}{2}\,a\,b$, the pressure at right angles to the surface will be twice the vertical pressure, etc.

The annexed sketch gives a graphical demonstration of these proportions. Here $a\,b$ = greatest radius and constructing tangent, P = vertical pressure, P' = pressure normal to surface, r = radius at different points.

Now, sine $\alpha = \frac{r}{a\,b}$ and : sine $\alpha' = \frac{P}{P'}$, the angle $a\,b\,P'$ being = 90°, it follows that $\alpha = \alpha'$, therefore

$$\frac{r}{a\,b} = \frac{P}{P'}, \text{ and } r\,P' = a\,b\,P.$$

or, the *radius multiplied by the pressure at right angles to the surface" is the same over the entire surface.*

J. HAUG, M. E.

Fig. 1.

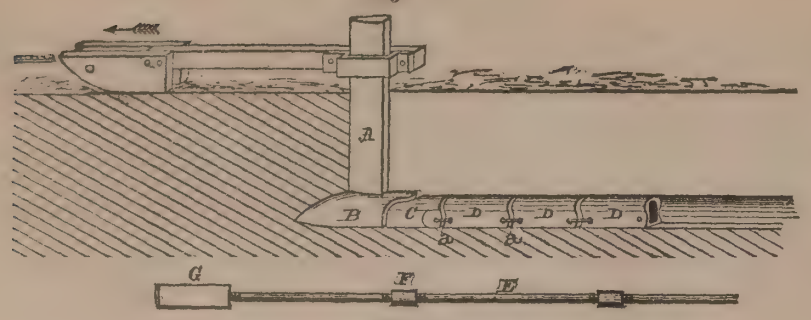


Fig. 2.

IMPROVEMENT IN DITCHING AND TILE-LAYING.*

Fig. 1 is a perspective of this invention. Fig. 2 is the break detector.

A represents the vertical beam, which has a sharpened edge for cutting its way through the earth as it is drawn along by the capstan or other suitable power. To its lower end is secured the mold, B, which opens the furrow for the tiles. Fastened to its rear end is a solid casting, C, shaped somewhat like the tiles, D, that follow on behind, the tiles being fastened to this mold and to each other by means of the staples, *a*.

Very frequently a break occurs in the line of tiles, and as there is no way of finding out just where it is, a break detector has to be employed, or the machine would be found impracticable. For this purpose there are employed rods, E, each one of which is of a known length, and which are united together by the coupling nuts, F. To the front end of these rods is screwed the solid casting, G. When a break occurs, this casting, G, is inserted into the orifice of the tile, and pushed along down into it, rod after rod being screwed together, as may be found necessary. When the casting reaches the break it should fall into the opening caused by the separation of the tiles, and then could not be pushed forward or backward. By knowing the number of rods pushed into the tiles and the length of each one, the place where the break is known. A hole is then dug down to the tiles, the break mended, the hole covered up, and the ditch completed.

* Patented March 27, 1877, by Thomas G. Coil, of Washington Court-House, Ohio.

THE SLIDE VALVE.

By JOSHUA ROSE.

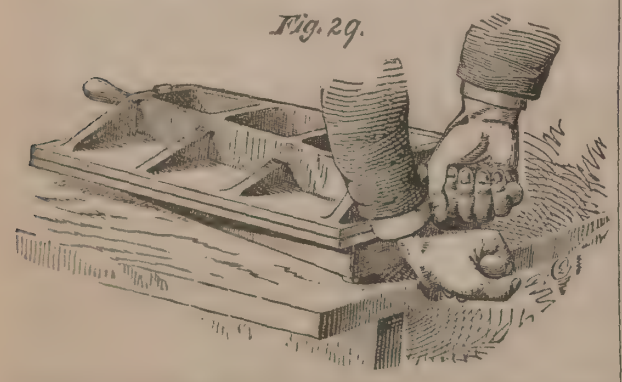
XIV.

Suppose that all slide valves were made of an equally good fit to their seats (and this is supposing a good deal when we remember that some engine builders put in the valves just as they were planed, making no attempt to fit them to their seats on the cylinder port faces, while others file them to a fit, and others again scrape both valve and seat true to a surface plate). Suppose that the co-efficient of friction, whether due to the pressure only of the valve to its seat or to the combined pressure and induced adhesion from perfect contact, was in all cases alike, when the valves were put in new.

Let us see how long they would remain so. First, then, an iron or brass casting, heated after having the surface removed by planing or filing warps, and its fit is impaired. With the loss of the fit goes a loss of the adhesion, and an admission of steam beneath that part of the valve which does not fit. How much it will warp depends upon the temperature to which it is heated, on how much was cut off the planed face, on how unevenly the valve casting cooled after being taken out of the mould, on the shape and thickness of the valve, and on several other elements. Let us presume, however, that a casting could be made so that it would not warp from having its surface skin removed, and that, by heating the valve after it had been once surfaced, the reset had taken place, and the valve, being refaced true, would not again warp from being reheated (as experience demonstrates that it always does), and that, being heated to a given temperature, it would remain as close a fit to its seat as it was when cold. Then, just so soon as the temperature varied, the expansion and shape of the valve would vary. Cast iron expands by heat, in proportion to the temperature. The valve has, acting on the inside area of its exhaust port, the cooling effects of the atmosphere, which finds ingress through the exhaust pipe. The exhaust steam itself lowers in temperature as its pressure decreases, and the live steam on the back of the valve is comparatively constant in temperature: as a result, then, the valve is continually changing in form from the expansion due to the high temperature of the exhaust steam during the early part, and the lower temperature during the latter part, of the exhaust. Now comes another and more important question, and that is: How far will the spring of the valve, from the pressure of the steam upon its back, affect the fit to its seat, and will it so spring as to permit of a fine film of steam finding its way beneath the wings of the valve, thus relieving, to a certain extent, the amount of its pressure to its seat?

If we take a pair of the plates shown in Fig. 29, and get

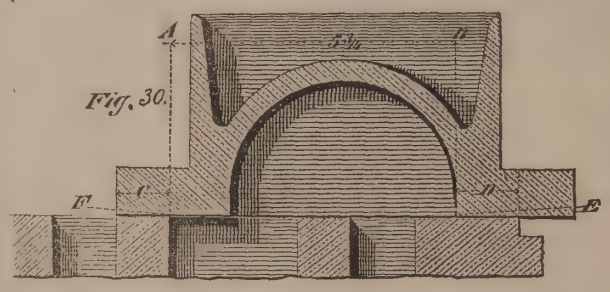
Fig. 29.



them so closely together that it requires, say, 340 lbs. to slide one upon the other, and then take hold of the plates by the handles, as shown in our engraving, we can pull them apart by exerting a force of about 130 lbs.; in other words, it will require but little more than one third as much power to pull them apart, in this manner, as it requires to slide one upon the other. In thus pulling them apart, we have, upon the back, whatever weight of the atmosphere the fineness of the fit leaves unbalanced, and, in addition, whatever amount of adhesion the perfect contact of the surfaces may induce. Hence, allowing a co-efficient of friction of 0·15, we should have 2,276 lbs. holding the plates together; and while allowing a co-efficient of 23·7, we should have 1,440 lbs. resisting the effort to pull the plates apart. The fact, therefore, that 130 lbs. will actually, under the conditions shown, pull the plates apart, appears at first sight not a little singular. The solution, however, is simple enough. The plates spring from the pressure placed by the hands upon them, and hence they unlap and come apart just as if we took two sheets of paper, placed together and soaked with water, and then took hold of two corresponding corners and pulled them apart. The plates are $\frac{1}{2}$ inch thick in the body, and the ribs are each $\frac{7}{16}$ inch thick and $2\frac{3}{8}$ inches high; and yet 130 lbs. applied as shown will spring them sufficiently to let the air get in between them. Let us in the light of this fact examine the shape and pressure upon a slide valve (assuming for the nonce that the pressure is the unbalanced area in contact multiplied by the steam pressure), and ascertain whether it is reasonable to suppose that the pressure of the steam upon the valve springs the wings, and permits the steam to find its way beneath them.

In Fig. 30 is shown an ordinary locomotive slide valve, the

Fig. 30.



ports being $1\frac{1}{4}$ x 17 inches, the bridges between ports 1 inch wide, the cylinder exhaust port $2\frac{1}{2}$ inches wide, and the valve having 1 inch of steam lap, covering the ends of the cylinder ports 1 inch at each end. When the valve is in the position shown, it will be noted that there is a very large proportion of the area of the valve unsupported by the seat; the area of this portion will be in this case $5\frac{3}{4}$ inches, as marked in the engraving, one way, and 17 inches the other =97·75 inches. Now supposing the steam pressure to be 130 lbs. per inch: then 97·75 × 130 = 12,707 lbs., the assumed pressure of the valve to its seat, tending to spring the flanges or wings in the direction denoted by the dotted lines, E and F, respectively. What have we to offset this amount? The area of one bridge equals 17, the area covered under the valve flange at D equals 11 inches, and the amount of the valve flange overlapping the ends of the steam ports equals 15·5; total 43·5 square inches, which, multiplied by the steam pressure, would give 5,855 lbs. as the pressure tending to spring the valve wings in the direction marked. There will, it is true, be a pressure placed on the underneath side of the valve by the exhausting steam, the area thus acted on being, in the position shown, 97·79 square inches; but it can scarcely be advanced that this pressure can be sufficient to relieve the valve from its liability to spring from the 5,855 lbs. on the other side.

Theoretically, a valve will spring of its own weight; and that it will spring from the pressure which a man can put upon it with his hands, I have often found in facing valves up. For example, if, in trying the valve on the surface plate, the former is pressed in the middle by the hands to make the plate mark the face plainly, and the valve is fitted under these conditions to a practically perfect fit, the surface plate marks showing equally all over, we may then let the valve lie upon the plate of its own weight only, and the marks will show (after of course moving the valve back and forth) at and near the edges of the valve only, showing that the pressure of the hands sprung it. There are plenty of instances of metal in the most solid of forms springing of its own weight: witness the Morton Poole rolls, which, though of chilled cast iron and 12 inches in diameter, spring and bend by the insertion between them of a piece of gold leaf $\frac{1}{5000}$ inch thick. There is yet another part of this question, however, which is found in practice to be of the utmost importance, and that is (as a visit to any locomotive repair shop will demonstrate, by the engines that come in to be repaired), that the valve wears out of truth, and so does the seat. In my experience, I have chipped a full $\frac{1}{16}$ inch off valve seat faces without cutting the worn grooves out. I have examined, or had come under my observation, at least 400 slide valves, and I never saw one that was, after working three months, of a sufficient fit to its seat to require one pound more than its own weight to lift it from its seat; whereas, if such a valve as is shown in Fig. 30 were of a practically perfect fit, it would require, when in mid-position, some 800 lbs. to lift it vertically, taking hold of the ribs outside the arch. The fact is that the bridges wear hollow lengthways, and hollow, as denoted by a straight edge, over the seat and across the bridges. Then there usually wears in the seat face a groove at right angles to, and close to, the edges of the ports. To remedy this, a practice sprung up in England, in about the year 1865, of drilling, in the face of the valve and in a line with the exhaust-port edge, a hole in each wing; and this hole may be found mentioned in recent English engine specifications. Now just so soon as a valve face loses its smoothness, though the grooves may be only the one hundredth of an inch deep, or like coarse file marks, it become impracticable to exclude the surrounding air at atmospheric pressure, let alone steam at a high pressure, from between the surfaces.

I have a plate of the same size as those shown in Fig. 29, which has been planed and not fitted in any way. The planer marks are all intact. By placing a finished true plate upon it, the partial vacuum between the two will lift the planed one; but in about ten seconds it will fall, because the weight of the plate causes it to sag, and the air travels along the fine planer marks until there is not sufficient vacuum to sustain the weight of the plate, which is about 20 lbs. Now since the planed plate can be lifted by the vacuum, it is at least as good a fit as an ordinary slide valve, and under a steam pressure would undoubtedly be steam-tight, although the steam, like the air, would find its way along the planer marks, and thus counterbalance a large proportion of the pressure placed by the steam on the back of the valve. How much the elements of warping from expansion, changing form from irregular temperature, and counterbalancing from steam finding its way beneath the valve, will affect the pressure of a valve to its seat whether these causes act either in concert or partly counteract each the other, will depend upon the shape, size, strength, etc., of the valve.

FINIS.

The Maiche Battery.—The inventor states that when his platinized carbon battery is charged with water acidulated with 10 per cent. of sulphuric acid, a zinc surface of 25 square centimetres is sufficient for the production of electric light. The electromotive force is, however, only about two-thirds as great as Bunsen's. By charging with bichromate of potash, he makes his battery the most intense of all, for the two forces are combined, and it possesses an electromotive force superior to that of the bichromate, while furnishing a double quantity of electricity. His battery has, therefore, the advantage of either being charged with simple acidulated water, or with the addition of the bichromate which makes it the most powerful known electro-generator.—*Les Mondes.*

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

Berlin Pneumatic Dispatch.—The proposed pneumatic dispatch in Berlin embraces 26 kilometres of tube, and has 15 initial stations. The wrought iron tubes have a clear breadth of 65 millimetres, and lie about one metre below the surface of the ground. The letters and cards which are to be forwarded, have a prescribed size, and are enclosed in iron boxes, or cartridges, each of which can hold 20 letters or cards. In order that they may pack closely, they are covered with leather. From 10 to 15 cartridges are packed and forwarded at a time; behind the last cartridge is placed a box with a leather ruffle, in order to secure the best possible closure of the tube. At four of the stations are the machines and apparatus needed for the business. The forwarding of the boxes is effected either through compressed or rarefied air, or through a combination of the two. Steam-engines of about twelve horse-power are used for the condensation or exhaustion of the air. Each main station has two engines, which drive a compressing and an exhausting apparatus, the steam for each engine being furnished by two boilers. Large reservoirs are employed, both for the condensed and for the rarefied air. The former has a tension of about three atmospheres; the latter, of about 35 millimetres of mercury. The air, which is heated to 45° C. by the compression, is cooled again in double-walled cylinders which are surrounded by water. The velocity of the boxes averages 1000 metres per minute, and a train is dispatched every 15 minutes. Each of the two circuits is traversed in 20 minutes, including stoppages. The entire cost of the enterprise will be about 1,250,000 marks.—*Dr. Grünberg, in Wochenschrift des Vereines Deutscher Ingenieure,* (*per J. Frank Inst.* lxxiv, 12).

French Railway System.—In a memoir of M. de Franqueville, M. F. Jacquin reviews the relations between the railways and the State, in different countries, coming to the conclusion that France alone has solved the difficult problem of reconciling these two grand principles: authority and liberty. The whole territory of France is divided into six grand railway-departments, in each of which, with a few unimportant exceptions, all the railways have been conceded to a single company.

Office books, very well devised, define the rights of the State and those of the company. Free to move within prescribed limits, the administrative councils and their immediate subordinates strive to develop commercial relations, or even to create them where they do not already exist.

In each department the different modes of technical working, the improvements to be made in the rolling stock, the questions relative to maintenance, to beneficial funds, and to retiring pensions for a clientage of more than 200,000 men, are all daily and carefully studied under different aspects, the very diversity of view furnishing guarantees of true progress and success.

At the same time the State, invested with important rights, by those same office books, exercises a continual surveillance over the companies. By the engineers of control and the subordinate commissioners, it is informed of the least incident which occurs on the roads. No tax is collected without having been confirmed, that is to say, without it has been shown by thorough examination that it is according to the conditions of the contract. By inspection of the finances the State penetrates into all the details of the combined action of the companies.

In time of peace the State is thus in a position to intervene at any instant, in the management of the railway companies, and to protect the public, if necessary, against monopoly. In time of war the immense property of the companies, together with their numerous disciplined and systematized corps pass under the control of the State; the workshops of the companies, true arsenals, are ready to execute the most difficult commands, to grind wheat and to make arms.

In fine, in 80 years, the entire network, which will have cost nearly $3,000,000,000, will be completely redeemed; all the capital and bonds will be reimbursed by annual levies on the working receipts, and the State will enter into full possession of a property sufficient to extinguish the public debt.

This system of equilibrium between the State and the companies, which the English call the "French System," may thus briefly be defined:

The association of the State and the companies, formed in order to assure the completion of the national network of railways, the advantages of the prosperous lines being partly employed for the benefit of the unproductive lines.—*Ann. des Ponts et Chaussés,* (*Jour. Frank. Inst.* lxxiv, 71).

Ice Breaker.—An ice breaker recently invented by a Norwegian engineer, M. Meinirk, resembles a plowshare and is moved by two propellers. Two centrifugal pumps eject a strong stream of water on the pieces of ice and thereby clears the passage for vessels. M. Meinirk thinks, that with his apparatus, the port of Christiania can be kept clear of ice at little expense. The apparatus costs but 360,000 francs, and is so formed that it can be used as a dredge when not used to break up ice.—*Moniteur Ind. Belge,* iv. 275.

Modern Spring Making.—Formerly springs were made entirely by hand, but to-day machinery does all the work except the final setting and tempering. The ears are dropped out and prepared by machinery, the steel is prepared for the ears by another machine, while still another places them in position and secures them, when they are again heated and placed in a welding machine called a header. The steel for the outer plates is cut off by one machine and drawn out by another, and the plates known as filler—the under main plates—are also drawn down by one machine and turned by another. The spring is then taken to the setter and temperer. The plate is heated the whole length, and formed to fit the preceding one by a hand-pincing process, and while still red-hot it is put in the bath or tempering vat, which is a metal tub filled with oil and resting in a wooden tank in which there is a continuous stream of fresh water running. After tempering, the springs are refitted, put together, and placed under a steam-tester, when, if perfect, they are ground, buffed and finished. The time required to make a pair of four-plate buggy springs is at present about three hours, or perhaps one-fourth the time required by the old-fashioned method, and, at the same time, a superior article is produced.—*The Hub,* xix, 162.

A Novel System of Navigation.—We give a description of the steamer "Alpha." She runs by steam, but without propeller or paddle-wheel. She was built in Baltimore, is 43 feet long, and 7½ tons burden. Amidships is a boiler, and in the place of an engine, a No. 7 Knowles pump. The steam furnishes the motive power of the pump, and the pump moves the boat through the water at the rate of eight knots per hour. The water to supply the pump is drawn from the stream in which the boat moves, unless an accident to the hull should occur, when the motive power of the vessel would be drawn from the leaking hold. Four copper pipes, 2½ inches in diameter, are connected with the pump. The ends of these pipes terminate in heavy brass nozzles five-eighths of an inch across; two opening flush with the stern of the boat four feet below the water-line on either side of the rudder. The other two nozzles open flush with the stem, one each side, about a foot above the keel. With sixty pounds of steam in the boiler, the pump makes 180 revolutions per minute, each revolution sending a stream of water forcibly through either the stem or stern nozzles. To go ahead the water is driven through the stern nozzles, and vice-versa, and so the boat is pushed on. The water is scarcely disturbed—a prime necessity on the canals. With her present boiler and pump, the Alpha can, it is said, make eight knots an hour—ten easily with a larger pump.—*Saward's Coal Trade Journal,* xiv, 2.

A New Electric Railway Signal.—Another invention pertaining to electricity, quite as wonderful as the telephone, though, perhaps, less calculated to attract popular notice, has recently been secured by patent in the United States to a Swedish inventor. The apparatus is an automatic railway signal, which enables the station officials to know the precise position of any train at any time. It gives sound signals to the engineer, and at the station before the train enters, thus enabling switches to be cleared and arranged in time to prevent accident. If two trains approach each other, whether running in the same or opposite directions, the engineers of both the trains receive signals in time to prevent collision, and the station people are at the same time automatically informed of the positions of both trains. Any train may, by stopping at certain points of the road where "contracts" are arranged, open telegraph communication with the stations at both ends of the route, and two trains may in the same manner telegraph to each other. A complete record is automatically kept at each station of the speed of each train, and of the exact time it enters or leaves the station. Stop signals may be sent at any time from the stations to any train while moving. The apparatus may be arranged to send stop or danger signals to trains approaching swinging bridges which are not properly locked or fastened.—*Railway World,* iii, 605.

Progress of the St. Gothard Tunnel.—The advancement made on the St. Gothard Tunnel during the week before last, was 29 m. at the Gœschenen, and 21 m. at the Airola end. A progress of 7.35 m. per day.—*Moniteur Indus Belge,* June 20, 1877.

MINING, METALLURGY AND MINERALOGY

The Bouniard Furnace.—The furnace invented by M. B. Bouniard, for transforming cast iron into iron or steel by the injection of air and mechanical stirring, with a movable oscillating part for tapping the metal, is described as follows:—

It is composed of the fusion chamber heated by gases in the system of the Siemens regenerator, or by an ordinary fire as in any other reverberatory furnace. The part of the bed which receives the metal, as well as the corresponding portion of the furnace, is distinct on each side from the fixed portions of the furnace, through which the gases alternately enter and make their exit. The arched portion of the part has an opening in its middle for the passage of an injector composed of a hollow tube surrounded by refractory clay; into this tube air is forced at a determined pressure, which escapes into the molten metal, which is previously melted either in the furnace itself, or in some reverberatory furnace, if it is desired to obtain a more rapid operation.

The object of injecting the air into the molten metal is, as in the Bessemer process, to refine it, and in order that all the metal which composes the bath may undergo this transformation, a rotary movement is imparted to the injector. The fast and loose pulleys are put in motion by some motor, and through the medium of a cog-wheel the fixed pulley turns the shaft to which it is secured, and by means of an endless screw, also keyed to the same shaft, puts in motion a worm wheel on the shaft of the injector; the movable means of fastening this last wheel permits the injector to be moved vertically during the rotary motion.

By a peculiar form of the lower part of the injector (helicoidal form) it also puts the molten metal in motion in such a manner that two things occur at the same time—the refining of the metal by the injection of the air, and stirring the metal—operations which greatly facilitate (or shorten) the process of the making of iron into steel, and render the metal homogeneous. Then when it is thought the operation is sufficiently advanced, the injector plunger is withdrawn, and the hand wheel which controls the gear wheel through the pinion is manipulated. On the same shaft with the wheel are two other wheels gearing into the two racks which raise the plunger.

Then, as in the Martin furnace, the molten metal can be tested and the necessary addition of cast metal or iron introduced to obtain the desired quality.

The result being obtained, the drawing-off of the metal into the ingot moulds becomes very easy by the tilting movement which can be imparted to the furnace. The bed, as well as the entire movable portion of the furnace, is placed on a strong cast-iron plate having trunions which are carried by the truck.

The pivoting point of this portion of the furnace will be then at the trunions. The track once in place, is kept in the position it occupies by bars having regulating screws.

By turning the hand wheel, which carries an endless screw, the pinion will be put in motion through the medium of the worm wheel and the tooth segment, the centre of which is the same as the centre of oscillation of the furnace, will be moved over. By this simple and easy movement the movable portion of the furnace is transformed into a virtual ladle, but with this great advantage, that there is no fear of the metal becoming cool in the ladle, because the currents of gas will continue to pass through the furnace and keep up the fusing temperature. One can thus take all the time necessary for drawing off every portion, however difficult it may be, and take determinate quantities of metal with the facility of being able to weigh it.

In conclusion, the furnace gives the following advantages:—

(1) This arrangement permits the melting of the metal on the same hearth of the furnace, which simplifies and cheapens the plant.

(2) Facilitates the refining of the metal by the injection of air into the bath (as in Bessemer process) and by the stirring motion of the injector, an operation which renders the metal homogeneous, since the motion compels every particle of the metal to change its position, coming in contact one after the other with the air injector; and not only does the injector impart a rotary motion to the metal on the hearth, but also

by its spiral form, it causes the surface of the bath to be constantly renewed, so as to put the different particles of metal successively in contact with the currents of the flame.

(3) It facilitates the making additions of iron, and for the end of the operation of employing the same mode of feeding as in the Martin process—a feed which determines the quality of the metal, and increases the facility of making tests to ascertain the quality before tapping it.

(4) The tilting motion of the part of the furnace corresponding to the bed which permits the pouring of the metal with pleasure, and in a determinate quantity without having to make a tapping hole.

(5) It removes the necessity of stopping, as in ordinary furnaces, for repairs, since the movable portion can be easily changed even while in operation, and be replaced by another movable part in exchange, where it would have been necessary to first repair and reheat in a furnace like the melting furnace. —*Saward's Coal Trade Journal*, xiv, 2.

Coal Cutting Machinery.—The *American Manufacturer* has an account of experiments now being made in a new coal mine near New Straitsville, Ohio, with a new coal-cutting machine. The cutting instrument is a long horizontal bar, covered with teeth of hard steel. This is caused to rotate very swiftly and is pushed foreward at the same time by a positive feed motion a distance of about five feet, undermining the coal by cutting a smooth cavity about five feet square at the bottom of the vein in from five to six minutes. The rotating bar is then automatically withdrawn, and the apparatus moved into position for another cut. The motive power used is compressed air.

Coal cutting machines are now being successfully used in Scotland. One of the kind in use there was exhibited at the Centennial. The machine now being tried in Ohio, an American invention, is of an entirely different type, and is stated to give much better satisfaction than the Scotch machine.

We shall look with much interest for further results from these trials, as it is not unlikely that they may be the forerunner of an important change in the method of coal mining.—*Manuf. and Merch. Advertiser.*

Another Source of Coal Supply is soon to be added to the list of mines that now furnish the requirements of San Francisco. A new discovery of coal deposits on the Pacific coast, was announced by the arrival of the schooner "California," on May 9th, from Ounalaska, Alaska Territory, she bringing 40 tons, which was sold to dealers at $8, and to consumers at $10 per ton. A company has been incorporated under the name of the Kimberly Coal Company, and in due course of time expects to receive some 500 tons for further tests. In 1871, San Francisco received 565 tons from Queen Charlotte Island, and 18 tons from Sitka. The latest important development previous to this was that of the mines at Ione. Large quantities are now being taken by the railroad company, principally for its own use.—*Railway World*, iii, 607,

Rare Minerals in the North of Scotland.—The accidental use of a mass of granite for building purposes near Tongue, in Sutherlandshire, has led to the detection of several rare minerals, and of quite a remarkable number of species and varieties associated in the same mass of rock. From among the fragments of the boulder, pieces of a bright green stone were sent to the museum of the Duke of Sutherland by Dr. Joass, of Golspie. These were afterwards analysed by Prof. Heddle, of St. Andrews, and found to be the variety of orthoclase felspar, termed amazon stone. For the purpose of more careful examination as to the mode of occurrence of this uncommon substance, Prof. Heddle has recently visited the locality, which is the side of the ridge rising on the east of the village of Tongue. He found the granite mass to be merely a large boulder, and had it thoroughly broken up. It has yielded the following remarkable assemblage of minerals :—amazon stone in simple and twin crystals, radiated cleavlandite, lepidomelane, pinite, fluorite, sphene, zircon, magnetite, ilmenite, allanite, smoky quartz with peculiar faces, and a mineral which a carefully instituted comparison shows to be thorite passing into orangite. The specimens of amazon-stone obtained from the boulder are of unparalleled magnificence. One which has been sent to the museum of the Duke of Sutherland exhibited a surface of some three square feet, about a dozen large crystals, of which eight were unbroken and perfect. One crystal, unavoidedly broken in the extraction, showed the following extraordinary dimensions :—viz., a length of 15½ inches, with a breadth and thickness of ten and eight inches respectively. The minute structure of these crystals is peculiar, and has been fully described in a recent paper by Dr. Heddle on Scottish felspars, in the *Transactions* of the Royal Society of Edinburgh. The exceedingly rare thorite was found in only a small quantity. From an examination of the granite of this and other boulders on the same hill, it appears that they have probably come from the huge mass of Ben Laoghal, which lies a few miles inland to the south-west. Should this be their origin, we may expect yet to find new sources of amazon stone, and perhaps other rare minerals, among the numerous corries and crags of that picturesque mountain.—*Nature*, xvi, 148.

—There were mined last year in Great Britain and Ireland —134,125,166 tons of coal, 2,071,983, tons of fire-clay, 12,-159,580 tons of ironstone, and 632,656 tons of shale. The number of persons employed above and below ground was 514,532. Of these, 409,229 worked underground and 105,-303 above—6,055 of the latter number being females. No females are employed under ground. The ages of both sexes ranged from 10 years upward. The total number of accidents was 839, and of deaths caused thereby 933. 42 of the accidents were fire-damp explosions, causing 95 deaths.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Utilization of Parchment-Paper Waste.—In the first April number of *Dingler's Polytechnic Journal*, C. O. Cech calls attention to the fact, that in the manufacture of parchment-paper, after the treatment with sulphuric acid there is a large amount of waste, which cannot be converted into paper, and which is commonly burned under the boilers. In a single factory this waste often ranges from 750 to 1500 kilogrammes per month. It is so rich in cellulose that it seems desirable to turn it to a more profitable use, and such use is suggested by the method introduced in 1857 by Roberts, Dale & Co., Warrington, for manufacturing oxalic acid by heating sawdust with caustic alkali. When the carriage of the waste is attended with small cost, it can probably be worked so as to yield a more profitable return than Tessié du Motay's patent method* for making oxalic acid from turnips, or the process of Possoz† for preparing it from wheat bran. The factory of Dr. Kunheim, in Berlin, which yearly makes 200 tons of oxalic acid from sawdust, has undertaken to give M. Cech's plan a thorough trial.—*Journal Franklin Inst.* lxxiv, 15.

Researches on the Irisation of Glass.—MM. E. Frémy and Clémandot.—In a former memoir on the aventurine of Venice the authors have shown that it is possible to obtain a glass comparable to that once manufactured in Italy by causing silicate of ferrous oxide to react upon silicate of copper in a vitreous mass, and at a suitable temperature. Under these conditions the silicate of iron passes to the maximum of oxidation, reducing the silicate of copper, and producing in the glass those metallic and brilliant crystals which characterize aventurine. Glass, submitted to influences which determine its gradual decomposition, becomes covered with slender laminæ, which produce very remarkable phenomena of irisation. This alteration of glass may be witnessed either upon glasses which have remained under water or in moist ground, or upon the windows of stables exposed to ammoniacal vapors, and especially upon glass objects found in ancient burial places. M. S. Meunier has exhibited a glass iridised under the influence of the acid vapors thrown off by certain volcanic ashes. The authors have attempted to produce in a regular manner this irisation, which gives glass the aspect of pearl or of nacre, and to render it permanently adhesive. After numerous attempts they have succeeded in the most complete manner. Their process consists essentially in submitting the glass, under the influence of heat and pressure, to the action of water containing 15 per cent. of hydrochloric acid. Several kinds of glass are suitable for this operation, whilst others are not adapted for it ; the chemical composition and the conditions of reheating and annealing have an influence upon this phenomenon. In the manufacture of ordinary glass the ease with which it becomes iridescent is a defect. This is especially the case with glass intended for bottles, optical glasses, &c., the resistent power of which may be tested by submitting it to the process devised by the authors. —*Druggist Circular*, xxi, 118.

Phosphor Bronze Wire Ropes.—M. J. Manne, the manager of the Phosphor Bronze Works, at Val-Benoit, Liege, has made pit ropes entirely of this alloy. Phosphor bronze ropes are said to have the advantage of offering great resistance to strains of traction, of being very pliable and inoxidizable, and of resisting any attack of corrosive water, while the wear due to the contract of the wires is less than in any other metallic ropes ; they also preserve their pliability after wear. These phosphor bronze ropes are used in Belgium, at the Bois-du-Duc, Horloz, and Courcelles Nord collieries, among others.—*Saward's Coal Trade Journal*, xiv, 2.

Colored Lead-pencils.—Red, brown, green, and other colored lead-pencils are made by bringing kaolin or pipe-clay to a doughy consistency with water, and then mixing the mass in a paint-mill with any earthy or metallic pigment of the color desired.—*Papier Ztg.*, 1877, 402.

**Bull. de la Soc. chimique* 1874, p. 187.
†*Wagner Jahresbericht*, 1858, p. 110.

Porotype.—Porotype is, we learn from the *Photographisches Archiv*, a newly devised process for copying copper-plate engravings, woodcuts, and other designs of a like nature. It is based on the principle that porous paper which has been printed upon by fatty ink loses, wherever ink attaches, its porous character. An engraving upon paper is only porous when there is no ink, and will neither allow gas nor liquid to penetrate wherever the black ink appears. A gas which acts upon a certain chemical agent, and either bleaches or discolors it, is permitted to penetrate a copper-plate engraving or woodcut where possible, and, coming into contact as it permeates with paper which has been suitably prepared, brings about a reaction—that is to say, wherever the gas has found means to penetrate, the color of the prepared paper alters, and a copy of the engraving is in this way produced.

In the process, therefore, four papers are necessary ; one which is capable of generating gas, and which is soaked with hyposulphite of soda ; a second, or sensitive paper, which is, in fact, paper treated, first of all, with extract of nut-galls, and afterwards with sulphate of iron solution (ink paper) ; thirdly, filter paper ; and fourthly, oiled paper. The copying of the engraving may be effected in the leaves of a book under pressure. The engraving is put upon the sensitive paper, and upon the engraving is laid the generating paper. Over these is laid a sheet of filter paper which has been previously impregnated in dilute sulphuric acid ; then a sheet of plain filter paper ; and lastly, the oiled paper. The whole is pressed together for ten minutes, when the copy ought to be finished. A report upon the process by Professor Böttger is not very favorable to it.—*Sci. Am.* xxx, vii, 3,

Woven Materials Impervious to Gas and Water for Dry Meters, Etc.—A want long felt, as in the construction of dry meters, etc., of a good elastic material, impervious to water and to burning gas, and at the same time unaffected by hydrocarbons condensing from the gas, or impurities in it, has been met, according to Dr. Tieftrunk, by an article recently produced by Engineer Schilike, which will doubtless meet with many applications. Dry meters, in which it has been employed, have been noticably affected by use for half a year. Dry pressure regulators made with it have also been found very superior to the wet ones generally in use, and Dr. Tieftrunk states that by means of them he can regulate the temperature of an air or oil bath so that the highest variation will not exceed 2°. The article consists of woven material, impregnated with a substance that precipitates in the pores, and which combines a high degree of elasticity with the requisite strength, and is not rendered sticky, and does not lose in imperviousness or elasticity under the influence of the hydrocarbons present in burning gas. A sample was not impaired in any of these particulars by an immersion of three days, at a constant temperature of 104°, in hydrocarbons extracted from gas by cooling it at 4° below zero. The same was true after digestion with a solution of carbonate of ammonia, and with bisulphide of carbon.—*N. Y. Tribune.*

A New Battery.—Professor Emilio Broglio (we learn from an Italian source) has devised a new battery, based on a fact forgotten hitherto, though known to science—that, viz., of the dissolving of zinc in a solution of sulphurous anhydride, without the least development of hydrogen. His battery, made on this principle, is said to act excellently, and to give a very strong current. Professor Broglio calls attention to a curious phenomenon observed in the course of his experiments. When the zinc plate is immersed, either in a solution of sulphurous anhydride, or in one of bi-sulphite of potash and soda, the liquid is observed to lose color at first, then become for a few seconds of the same color as a solution of bichromate of potash ; this coloration commences at the zinc, and is diffused through the mass, as if absolutely independent. No salts of zinc are known to give such color.—*Eng. Mech.*, xxv, 357.

An Ink Recipe.—Prof. Böttger informs us, through the *Jhrsbcht. des Physik. Vrns. zu Frankfurt a. M.*, that a very excellent black ink, flowing easily from the pen, is furnished by making a solution of aniline-black in water. [Nigrosin or aniline-black is largely used for blacking leather.]—*D. Ind. Ztg.*, 1877, 248.

Cleaning Platinum Crucibles.—Prof. F. Stolba recommends the use of boracic acid and the double fluoride of boron and potassium for the cleansing of platinum crucibles. Besides being very efficient as a cleansing material, it can be easily removed from the crucible when cooled—a property not possessed by the double fluoride alone, which is often used for this purpose.—*Fresenius' Z'tschrift*, xvi, 95.

Anæsthesia Produced by Chloride of Carbon.—Some time ago, M. Moret called attention to the chemical properties of tetrachloride of carbon. Recently he has shown the possible application of this compound as an anaesthetic in place of chloroform or ether. He concludes in describing a new process for its preparation.—*La Nature*, v, 63.

Electric Light Experiment.—On Friday night a series of interesting experiments with the Jablochkoff electric light took place at the West India Docks, under the direction of M. Denayrouze. The apparatus used for the occasion consisted merely of an electro-magnetic machine worked by a small steam-engine, some insulated wires, and the electric candles, which are the invention of M. Jablochkoff, and composed, as we have already described, of two carbons placed side by side with a slip of insulating substance between them, which burns away with the carbon exactly in the same way as the wax of a wax candle is consumed with the wick. The first experiment, in order to show the suitableness of the invention for dock purposes, consisted in the lighting of four of the "candles" in a large yard. The light thus obtained, which was shaded by ground glass, brilliantly illuminated the inclosure, it being possible to read small print at a considerable distance from the lights, while at the same time the eyes were not affected by the glare, as is the case with the ordinary electric light. The second experiment was confined to the illumination of the top story of one of the large warehouses, and this, like its predecessor, was equally successful. A large vessel at the quay side was also lighted up, as also was a portion of the quay. The whole of the experiments were very successful, and it was stated that each "candle" gave a light equal to 100 gas lights. The light is said to be much less expensive than gas.—*Nature*, xvi, 152.

—An adaptation of the Holmes distress signal has been devised by M. F. Silas, of Vienna, for the purpose of illuminating the sea when an attack by torpedo launches is possible. It consists of a shell containing a bottle full of a liquid capable of giving off phosphuretted hydrogen. Wetted sponge surrounds the bottle, which is broken by the discharge from the gun; the liquid coming in contact with the wet sponge speedily generates gas, which drives out two stoppers, and two streams of illuminating matter are poured upon the sea. *Eng. Mech.*, xxv, 357.

MISCELLANEOUS.

Influence of Anchor-Ice upon Fishing-Grounds.—Prof. Hind, to whose late researches in Labrador we recently called attention, has published some remarks on the effects of the formation of ground-ice in retarding the decomposition of fish-offal, and thereby in seriously damaging the value of the Labrador fishing-grounds. He shows that the ice formed on the sea-bottom freezes the offal, and protects it from being devoured by sea-scavengers and from decomposition: that every rise in temperature which prevents the formation of anchor-ice promotes the decomposition of the offal; that when this takes place, as it does every year under a covering of surface-ice, the water, not being aërated, becomes foul with gases and from the removal of oxygen, and that the result is fatal to the young cod and other fry which then seek the coasts in search of food. He states that vast multitudes of the yonng fish are, from this cause, destroyed every summer and autumn in the bays and fjords, and he accounts for changes which have taken place in the migratory movements of seals by this wholesale destruction of the food which they used formerly to find in the coast-waters. He recommends the utilization of the offal, which would not only eventually prove remunerative as a source of artificial manure, but would remove poisonous gases which are set free on the melting of the anchor ice at a time when they cannot fail to prove highly destructive.—*Nature*, xvi, 148.

Industrial Secrets.—A century ago what a man discovered in the arts he concealed. Workmen were put upon oath never to reveal the process used by their employers. Doors were kept closed, artisans going out were searched, visitors were rigorously excluded from admission, and false operations blinded the workmen themselves. The mysteries of every craft were hedged in by thickset fences of empirical pretensions and judicial affirmation. The royal manufactories of porcelain, for example, were carried on in Europe with a spirit of jealous exclusiveness. His Majesty of Saxony was especially circumspect. Not content with the oath of secresy imposed upon his work people, he would not abate his kingly suspicion in favor of a brother monarch. Neither king nor king's delegate might enter the tabooed walls of Meissen. What is erroneously called the Dresden porcelain—that exquisite pottery of which the world has never seen the like—was produced for 200 years by a process so secret that neither the bribery of princes nor the garrulity of operatives ever revealed it. Other discoveries have been less successfully guarded, fortunately for the world. The manufacture of tinware in England originated in a stolen secret. Few readers need be informed that tinware is simply thin iron plated with tin, by being dipped into the molten metal. In theory it is an easy matter to clean the surface of iron, dip it into a bath of the boiling tin, and remove it enveloped with the silvery metal to a place for cooling. In practice, however, the process is one of the most difficult in the arts. It was discovered in Holland, and guarded from publicity with the utmost vigilance for nearly half a century. England tried in vain to discover the secret, until James Sherman, a Cornish miner, crossed the Channel, insinuated himself master of the secret, and brought it home. The secret of manufacturing cast steel was also stealthily obtained, and is now within the reach of all artisans.—*Metal Worker.*

Varnish-Brush Keeper.—Into a wide-mouthed glass jar, placed on a rack for keeping it in the proper position, place a wire shelf fitted so as to keep its place in a horizontal position; then fill the jar to within an inch of the shelf with spirits turpentine, cover the mouth with a close-fitting tin cover, and the keeper is complete. Varnish-brushes may be kept in this way by simply wiping them out on the varnish cup, and laying them on the wire shelf until they are wanted again.—*The Hub*, xix, 155.

Fibrous Screen for Carriage Windows.—The Protective Ventilator Co., of this city, have just brought out a novelty in the shape of a fibrous screen for carriage windows, which answers the double purpose of screening the occupants from the sun, and excluding dust, dampness and draughts of air. It consists of a curtain of cotton-wool fibre, the same as used in the varnish room ventilators already introduced by the above-named company, and it is adjusted to a self-acting spring roller in the upper part of a window frame, the same as an ordinary curtain. The price varies somewhat according to size, ranging from $2.00 to $3.00 per curtain. Several carriage-builders are now testing the screen, and think they see several important advantages in its use, namely: the effectiveness with which it excludes dust, and second, the fact that the window may be opened in the coldest of weather without the occupants experiencing those draughts and sudden gusts of wind which so often make it undesirable—even impossible—to have open windows.—*The Hub*, xix, 159.

The Delaware River Front.—Some months ago the Pennsylvania and Reading Railroad Companies, seeing the necessity of having an outlet on the Delaware front, began to take measures to have tracks laid connecting their depots in the northeastern section of the city with the business portion of the city along the river.

As the Reading Railroad only desired a connecting line as far as Callowhill street, or along the widened portion of Delaware avenue, it all seemed plain sailing. But to make the Pennsylvania connection complete, it was necessary to pass from Callowhill to Dock street, along Delaware avenue, or that portion of the street that is the narrowest in width and the most crowded in business. To increase this part, according to the report of the Commission of Civil Engineers appointed by the Councils, would require at least $400,000. This outlay would necessarily have to be borne by the railroads which desire to use the street. This large sum it is not at all likely will be expended during the present year. In the meantime, the committees of Councils, the Reading and the Pennsylvania Railroads, the Girard estate trustees, and the merchants on Delaware avenue, had come to an agreement that would faciliate the transaction of business on the river front. This was that until the street was widened all proceedings looking towards an injunction to stop laying track upon the avenue should be stopped, on condition that trains should be limited as to time of running until said street was widened. This agreement was that trains should not be run between Callowhill and Dock streets, on Delaware avenue, between 7 o'clock in the morning until sundown, from May to November, and from 7 o'clock in the morning until 6 in the evening the rest of the year. It is not contemplated to lay any tracks on the line of the River Front Railroad until next fall. The operation of widening Delaware avenue will not be commenced until next year at the earliest.

A New Expedition.—Professor Nordenskjold's great expedition, for which a vessel has already been chartered at the price of 150,000 crowns, is to leave Gothenburg in June, 1878. It is to circumnavigate the whole of Asia through the Polar Sea, the Behring Straits, along the east and south coast of Asia, and to return to Europe through the Red Sea and the Suez Canal in the autumn of 1879. King Oscar has contributed 50,000 crowns towards the expedition. The principal expense of the expedition will be borne by Mr. Dickson, a merchant of Gothenburg.—*Iron*, ix, 780.

—Messrs. Hagstoz & Thorpe, Philadelphia, are getting out a lot of ten thousand of their parallel pliers.

—Jones & Laughlins, of Pittsburgh, are now at work upon the shafting of the new No. 3 Mill of the Eagle and Phœnix Manufacturing Company, of Columbus, Ga. About 6,000 feet of the $2\frac{1}{4}$ inch cold rolled shafting made by this firm will be required; Mr. Jordan, the Treasurer of the Eagle and Phœnix Company, having expressed a decided preference for this kind of shafting.

—Flour forms the principal article of export from this country to Brazil

—An immense Oil-tank, at Oil City, recently took fire. The proprietor offered five hundred dollars to have it extinguished. A philosophic mechanic accepted the offer, and availing himself of a steam boiler that stood a hundred feet from the burning tank, connected a two-inch pipe, and running it over the top of the tank in the form of a goose-neck, turned on steam, and in a short time the fire was out. The tank had then been burning five hours.

—Messrs. Jones & Laughlins, of the American Iron Works, shipped a load of shafting to Brazil on Monday.

—Fifty Thousand Elephants are annually slain to meet the English demand for ivory.

—A Railway across Newfoundland, which would shorten the ocean passage between America and Europe to three days, is a recently considered project.

—Fire Escapes are now occupying the attention of inventors and numerous practical and impractical devices for this purpose are weekly patented.

—The value of small inventions is exemplified in the returns realized by the inventor of a little device for lifting lamp-chimneys so that the wick might be reached without removing the chimney. The inventor of this appliance, realized, it is stated, sixty thousand dollars from his invention.

—Last Autumn forty-one American paper manufacturing firms agreed to work together to develope a European market for their wares, and their London agents have recently informed them that their foreign invasion is successful. This should encourage manufacturers of other goods to make systematic and well-directed efforts in the same direction.

Messrs. Baird & Huston, Kensington Iron Works, Philadelphia, have on hand at present three iron and one wooden vessel in course of construction, as follows: An iron twin-screw steamer for the United States Lighthouse Board. The vessel is 153 ft. long, 25 ft. beam, 10 ft. 6 in. depth of hold. The engines are double, 21 x 27 in., and have surface condensers. An iron passenger steamer for Delaware river service. A large iron tug-boat for sea service, out of New York. A wooden tug boat for Delaware river service. The United States revenue cutter, "Hamilton," is undergoing repairs. In addition to the above, the firm is building a large number of Wescott type casting and setting machines.

—There is reported to be every evidence of a revival of industry at Trenton, N. J. The Trenton Iron Company and Roebling's Wire Mill are both running with an increased force of workmen, and all the potteries are now in full operation.

—The Pratt-Whitney Company and Beach & Sons' Iron Works, at Hartford, Conn., have just finished one of the Lay torpedo boats. The boat is about twenty-five feet in length, and is built in the so-called cigar shape. It is propelled by the use of condensed gas, the movements being controlled by parties on shore. The engine and screw are of small proportions, but are very powerful. The explosive material is contained in the forward end and is fired by means of electricity.

—The Wood and Light Machine Co., Worcester, Mass., has recently shipped one of its patent shafting lathes to a large house in Prussia.

—Swift's Iron and Steel Works, at Cincinnati, have been running the rail trains for six months past on 30, 35 and 40-lbs. T rails for narrow gauge roads and a few orders for 60-lb. rails. They have also large orders for locomotive boiler iron and special irons for bridges, roof-trusses, etc.

—The Asbestos Packing Co., of Boston, has just moved into a new and larger factory. The sales of this year have been over three times as great as last year. The company makes steam packing, steam pipe and boiler covering and mill-board for steam joints for railroads and factories. The asbestos used is imported from mines in Italy.

—The packing manufactured by the United States Metallic Packing Co., of Boston, has been adopted by several leading railroads; also by a number of steamship companies, including the Old Colony, the New Bedford & New York, the Old Dominion, the Providence & Stonington, the Albany Day Line, and others.

—The Nashua Iron and Steel Co., at Nashua, N. H., is making Woodbury's patent car wheels, which have steel tires and rubber packing between the tire and centre.

—Buff & Berger, of Boston, manufacturers of surveying and scientific instruments, are making a large improved astronomical theodolite for Princeton College.

—The Wythe Speed Recorder Co. has put five more of its railway speed recorders on trains on the Mahoning Division of the Atlantic & Great Western, which makes 76 in use on that road. The Buffalo, New York & Philadelphia Company has adopted the speed recorder and put one in each caboose on the road.

—At a recent meeting of the Christ church (N. Z.) Philosophical Institution, Dr. Haast gave an account of the discovery of remarkable ancient rock paintings in the Weka Pass Ranges. Some of them are fifteen feet long; they represent animals of foreign countries, weapons and dresses of semi-civilized people; underneath are characters like those of the Tamil language, and those on the ancient hill found in the North Island.—*Nature*, xvi, 175.

—The great Moscow Polytechnic Museum was opened on June 12th by an extraordinary meeting of the Society of Friends of Natural Science.

EDITORIAL CORRESPONDENCE.

STRENGTH OF CYLINDERS TO RESIST INTERNAL PRESSURE.

To the Editors of the POLYTECHNIC REVIEW:

Gentlemen—At the end of an article written by Mr. Trautwine about the strength of cylinders to resist internal pressures, the writer suggests two questions: First. Were the hydraulic presses used at the Menai Strait bridges dangerously weak? And second. Is there not a flaw in the reasoning upon which Barlow and Rankine based their rules, which certainly appear in this instance to give thicknesses far too great for thick cylinders?

In answer to the first question, I would state that the Menai cylinders were made not of average iron, but of the very best material; that the first cylinder cast, in spite of all precautions taken, became porous; that the second cylinder broke while under pressure; and that the material for the third one, which successfully did the work, was cast and recast several times, a process now generally adopted in Europe for the material of hydraulic presses. The builders of the Menai presses were perfectly aware that the margin of safety for their cylinders was rather low, for a fourth cylinder was cast to take the place of the third one in case of an accident; but had the thickness been forty inches instead of ten inches, it would have been impossible to obtain a homogeneous and not porous casting. The only remedy in that case would have been the adoption of a larger area of piston in order to reduce the pressure, the combination of several cylinders, or a copper lining, as proposed by Mr. Hiram Haines, C. E., in your paper.

As for Barlow's and Rankine's rules, there is indeed a flaw in that given by Barlow as far as the whole reasoning is based on the hypothesis that the area of a cylindrical section remains the same when under pressure. The problem of establishing a strictly scientific rule for the cylindrical and spherical vessels is such a complicated one that Barlow and many others made a hypothesis in order to make the problem more simple. Brix, for example, whose rule was some time ago in use on the European Continent, supposes that the thickness of cylinders remains the same when undergoing pressure.

The formula given in Rankine's book was first established by the Frenchman Lamé, and is now the only rule for hydraulic presses and guns adopted in Europe; it could even be applied to water-pipes without giving unreasonable results. As Lamé does not make any hypothesis whatever in his reasoning, he therefore has given the most reliable formula, and I will endeavor to show that his rule has facts for its basis.

According to this formula, the strain in the material of the cylinder of the Menai press went up as high as 14,000 lbs. to the square inch. If even we assume the cohesion of iron to be 21,000 lbs. per square inch, the degree of safety does not exceed 1½. The strain on a press with two cylinders, at the Britannia bridge, was, after the Lamé rule, about 7000 lbs. per square inch, which would give a factor of safety of 3.

Let us now apply the Lamé rule to a press not making part of an "engineering monstrosity," but to a press doing useful work every day for years. Hummel, at Berlin, possesses a press the cylinders of which give 1000 tons pressure each, the principal dimensions being as follows:

Diameter of piston	602 mm. (say 24 inches)
Interior diameter of cylinder	628 mm. (say 25 inches)
Thickness	222 mm. (say 9 inches)
Water pressure in atmospheres	352

Lamé's rule gives a strain of 10,000 lbs. per square inch in the material of these cylinders when at work. By this and other examples it appears that the builders of hydraulic presses all agree upon the fact that it is impossible to get a suitable casting thicker than ten inches or so; and it appears also that the only flaw in Rankine's book consists in recommending a degree of safety for cylinders not less than 6. For cylinders which are to contain steam he is practically and theoretically right, but for very high pressures like those in hydraulic presses and guns, he is practically wrong.

Reuleaux's book (*The Engineer*), which is for the European continent what Rankine's *Civil Engineering* is for England, recommends for hydraulic presses a pressure of 4000 to 10,000 lbs. per square inch (see page 565), and the adoption of thin cylinder walls of the very best materials, while for steam boilers or water-pipes, he recommends, like Rankine, a factor of safety of 6.

The Lamé rule can be applied to thick and thin cylinders, but the extent of its use is, like many of the best scientific rules, limited by practical considerations. As for the simplest form of writing the Lamé rule, it is—

$$\text{Thickness} = \text{true radius} \left((n + \frac{n^2}{2}) \right.$$

where n is the ultimate cohesion in lbs. per square inch divided by assumed bursting pressure in lbs. per square inch.

Yours, respectfully, A. SCHLEICHER.

P. S. The following table, as copied from Reuleaux's book for comparison, may perhaps be of interest to some of your readers.

If we assume p to be the hydraulic or other pressure in lbs. per square inch, δ the thickness of the cylinder or sphere, r the interior radius, and S the strain tending to destroy the cohesion of the metal, then the theories of Brix, Barlow and Lamé give the following results:

	Spherical Vessels.		Cylinders.	
Values.	$\delta =$	$p =$	$\delta =$	$p =$
Brix.	$\frac{r}{2}\frac{d}{S}$	$2S\frac{\delta}{r}$	$r\left(\frac{\frac{p}{S}}{e}-1\right)$	$S \log. \text{nat.} e \frac{\frac{r}{S}}{-1}$
Barlow.	$\frac{pr}{2S-p}$	$\frac{2S}{1+\frac{r}{\delta}}$	$\frac{rp}{S-p}$	$\frac{S}{1+\frac{r}{\delta}}$
Lamé.	$r\sqrt{\frac{2(S+p)}{2S-p)}}-r$	$2S\frac{\left(r+\delta\right)^3-r^3}{\left(r+\delta\right)^3+2r^3}$	$r\sqrt{\frac{S+p}{S-p}}-r$	$S\frac{\left(r+\delta\right)^2-r^2}{\left(r+\delta\right)^2+r^2}$

BIBLIOGRAPHICAL NOTICES

THE STEAM ENGINE. By J. F. Bramwell, M. I. C. E. This little pamphlet, of 62 pp., 12mo., is one of the series of Science Lectures at South Kensington and contains two lectures by Mr. Bramwell on the Steam Engine and Boiler. These are especially interesting from the happy manner of their style and the accuracy of the historical introduction. The analysis of the various early engines and boilers is clearly given; and the development traced up to the present day. The stationary engines of Papin, Savery, Newcomen, Watt and Hornblower; the road engine of Cugnot; the locomotives of Trevethick and Stevenson, and later developments; the bed-post and "Bull" engine, Taylor & Martineau, Brunel, Sr., Mandslay, and others are tersely described. The engine of Dudgen is alluded to as possibly the nearest solution of the rotary engine problem. Mr. Bramwell does not commit the absurdity of placing himself on record against the rotary engine, although he does the advocates and inventors of rotaries a service by disabusing them of the idea that there is any actual loss of power by the crank other than the extra friction it causes. The various types of reciprocating engines are divided into four classes: 1st, non-condensing and non-expansive; 2d, condensing and non-expansive; 3d, non-condensing and expansive; 4th, condensing and expansive. He shows how that in the non-condensing and non-expansive engine high pressure must be employed to obtain any high degree of economy, and gives diagrams and tables showing the advantage of a high degree of expansion in these engines. With condensation and no expansion, it is shown that the greatest benefit by condensation is derived at the low pressures. The combined advantages of condensation and expansion are shown to increase as the cut-off takes place earlier, and condensation shown to become a duty with low pressures.

The superiority of the surface over the jet condenser is rehearsed, and the air and ejector condenser described. Mr. Bramwell is one of the few advanced heretics who agrees with this writer in condemning the fallacy of the compounding principle; and his diagrams show that with a pair of cranks at right angles and with two cylinders cutting off at half stroke, greater approximation of uniformity of tangential face is obtained than with a high and a low pressure cylinder with capacities as 1 to 4, and the first cutting off at ½.

The steam jacket is discussed at some length and its advantages pointed out, but the disadvantages seem to be omitted.

The governor is very briefly alluded to. The cause of reasoning by which wire-drawing is shown to be an advantage in a bad engine is curious. The indicator receives a brief notice, and the injector receives a very satisfactory explanation.

We had nearly omitted mentioning Mr. Bramwell's condemnation of the Cornish engine for water-works duty, especially when a stand pipe is used and the demand is irregular and generally necessitating much less than the maximum pressure.

We have no space to note Mr. B's remarks on the steam boiler. The little pamphlet (published by MacMillans of London and Van Nostrand of New York) is the best of its class that we have seen, and we hope that the others of the same series are as interesting and valuable. G.

☞Our Answers to Correspondents have been unavoidably crowded out this week.

SELECTED LIST OF U. S PATENTS.

JUNE 19TH, 1877.

Patents issued June 19, 1877, 275. Reissued, 16. Trade marks, 15. Designs, 13. Labels, 3.

192,046. FIRE PLACE. James Adair, Aleppo Township, Alleghany Co., Pa.

The grate bars are set lengthwise of the fire place and with a backward inclination so that the draught air and products of combustion are projected backward against the back of the fire-place.

It is also proposed to set the grate bars upon bearers which have a downward inclination towards the back, so that ordinary grate bars will present the desired inclination to the draught. It is also proposed to place the grate immediately over the ash pit and provide it with a rocking bar.

192,058. EMERY WHEELS. Wm. Esty, Fitchburg, Mass.

Emery, or corundum, grains of proper size is mixed with about an equal quantity of fine flour of the same material, and a quantity of broken glass, slate, or other vitreous substance. Mixture is moistened with gum-water or sour beer, sifted, molded, dried, and finally cemented into a cohesive mass by heat.

192,064. SPINNING MULES. Samuel George, Lowell, Mass.

The point of the cop is shaped by the nose peg which is attached to the sleeve and projects from it through the slotted arm. Said nose peg is traversed by means of a stud projecting from the sleeve and working in a screw of variable pitch, so that by turning the screw equal amounts at each return of the radial arm to an upright position, the proper shape is given to the cop.

192,066. MACHINE FOR SHEARING HATS. Delos W. Mitchell, Orange, N. J.

The hat is placed on a cone block which is mounted on a pivoted segmental frame adjustable on its pivots toward or away from the revolving cutter. The cone block is also adjustable longitudinally on its shaft by means of a tail screw.

192,167. METHOD OF ORNAMENTING METALLIC SURFACES FOR JEWELRY. Edward Huguenin, Philadelphia, Pa.

A number of thin plates of various colored metals are soldered to a bottom plate of greater thickness, and then rolled to the thickness required. The various colors are finally exposed by engraving.

192,179. MILL STONE DRESSERS. John McD. McIntyre, Lockport, N. Y.

The carbon point is secured to the tool stock, which is so mounted as to enable the point to operate at any desired angle and inclination. The centering screw engages with the end of the spindle, or in the recess of a temporary center piece.

192,192. MACHINES FOR MAKING PLUMBERS' TRAPS OF LEAD. John Robertson, Brooklyn, N. Y.

At the top is the lead containing cylinder with two ducts leading up to an annulus through which the lead is forced by a piston operated by a hydraulic press.

Below the ducts there is a transverse slide having a single orifice, and as this slide is adjusted toward one side or the other, it enlarges the passage to one of said ducts and correspondingly closes that of the other, so that the lead is forced up the two ducts and united in the annular die under different pressures at the opposite sides, and the resultant pipe is curved. At the proper moment the position of the slide is gradually reversed and the curvature of the pipe is also reversed.

When the slide is adjusted so as to equalize the pressure the resultant pipe will be straight. The whole apparatus is hung upon trunnions.

192,216. HORSE-SHOE NAIL MACHINE. R. M. Cummings, Nashua, N. H.

The blanks fall upon a bar projecting from a gripping die, which sustains them while being gripped and headed, and then recedes and discharges them from the machine. The forward feed is effected by a pawl which engages with a rack bar attached to the carriage.

192,256. PRINTING PRESS. William A. Harp, Covington, Ga.

The bed is flat and stationary. At its side are ways over which an impression cylinder is rolled by slotted arms rocked by a treadle. The ways are lifted and lowered on arms of shafts rocked by the engagement of flanges on the cylinder with crank arms on the shafts. Swinging levers fulcrumed on the cylinder shaft are linked to the inking roller carriage and their free ends engage guides on the sides of the frame.

192,288. APPARATUS FOR CHARGING AND RECHARGING RETORTS. Thomas F. Rowland, Brooklyn, N. Y.

Coal is discharged from a revolving meter through an adjustable telescopic chute into the retort charging scoop, having a removable bottom. After the scoop has been projected into the retort the charge of coal is deposited by the withdrawal of its bottom. The coke is removed with a rake. The carriage of the rake and charger run upon wheels and are traversed upon their rails by endless chains and suitable gearing. An air engine placed upon the frame supporting the different machines traverses the frame on rails in front of the retorts and operates the different machines.

192,296. MACHINE FOR MAKING LOOM HARNESS. Jos. Sladden, Lawrence, Mass.

The machine is adapted to make heddles for fancy looms. A finger is automatically operated by a pattern cam to withdraw at the requisite intervals the length of yarn or twine from the reach of the twister, thereby interrupting the formation of the heddles while the other parts of the mechanism continue to operate.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, JULY 21, 1877. NO. 3.

SEWING MACHINE STITCHES.

We acknowledge our indebtedness to the *Sewing Machine Journal* for the accompanying engraving, reproduced from *Knight's Mechanical Dictionary*, showing the various sewing machine stitches as given by Mr. G. W. Gregory, of Boston, Mass., and who was one of the Centennial Judges, in Group 22.

SINGLE THREAD.—1. The ordinary *running*-stitch used in basting; 2, the *back*-stitch; 3, the *fast*-stich; 4, *chain*-stitch; 5, *coiled*-loop chain-stitch; 6, *knitted*-loop chain-stitch; 7, *knotted*-loop chain-stitch; 8, loop enchained by second alternate stitch; 9, each loop locks and enchains alternate loops; 10, *staple*-stitch for waxed threads.

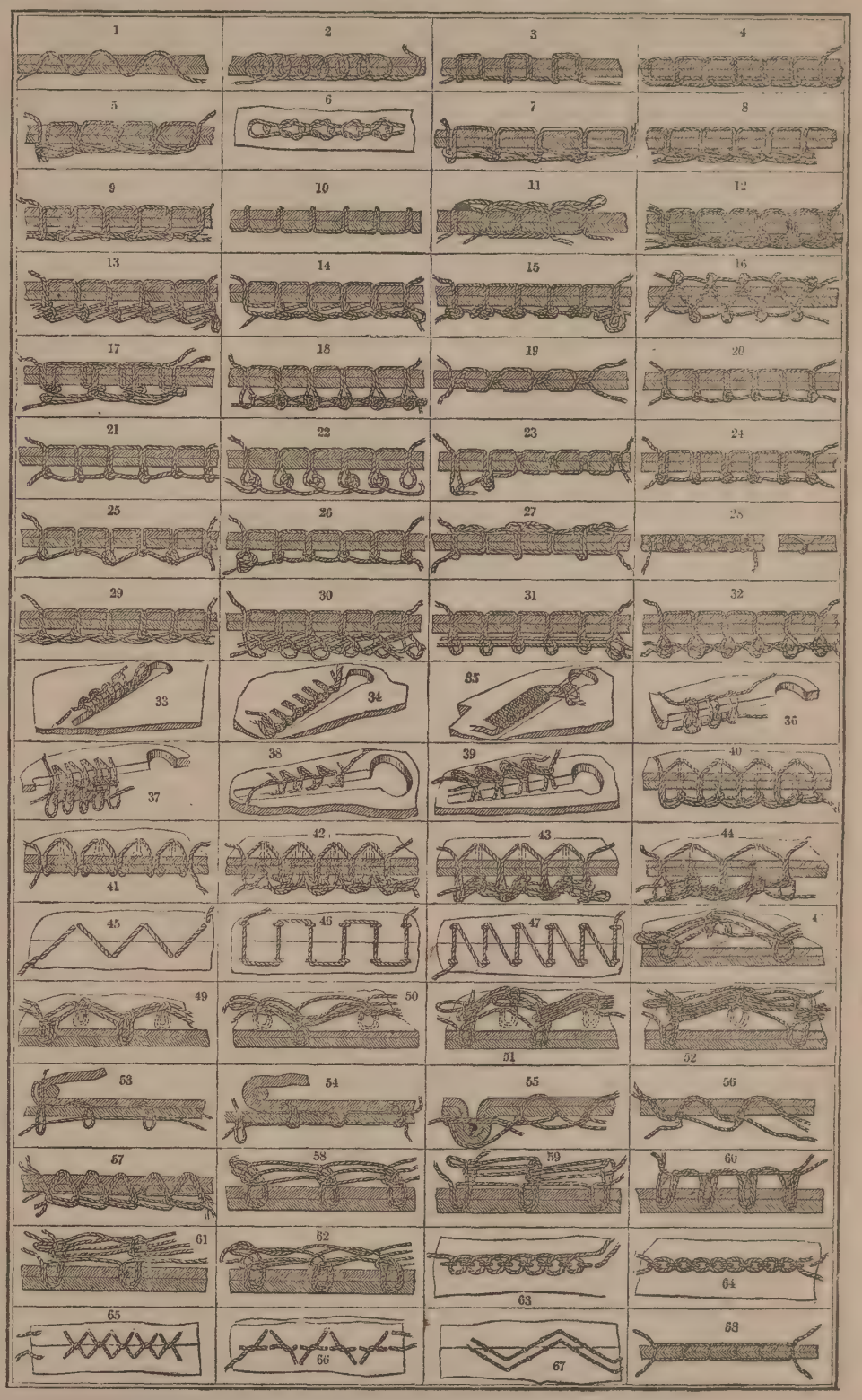
TWO THREADS.—11. *Double needle* chain-stitch; 12, double thread chain-stitch two threads, one needle; 13, double-looped stitch; 14, chain with interlocking thread; 15, under thread through its own loop; 16. two needles penetrate fabric from opposite sides; 17, two needles working from the same side of the fabric; 18, double interlocking loop; 19, *lock*-stitch; 20, coil in needle-thread; 21, double coil in needle-thread; 22, coil in shuttle thread; 23, double coil in shuttle thread; 24, knot-stitch, every stitch knotted; 25, knot-stitch, every other stitch knotted; 26, knot-stitch (different knot); 27, shuttle-thread drawn up to form embroidery; 28, *wire*-lock, thread locked by wire.

THREE THREADS.—29. Two shuttles, each locking alternate loops; 30, double loop with interlocking third thread; 31, two shuttle-threads locking each loop; 32, two shuttle threads intertwining and locking each loop.

BUTTON-HOLE STITCHES.—33. Single thread, loop of needle-thread drawn up over the edge and locked by needle at its next descent; 34, two threads. Bights of needle thread, above and below, extend to the edge of the fabric, and are locked by shuttle-thread; 35, two threads, needle penetrates back from edge, its loop passed to and interlocked by the needle at its next descent over the edge, and this needle-loop locked by shuttle thread; 36, shuttle-thread drawn up over the edge of the fabric to the line of the needle-thread; 37, needle loop through the fabric, locked by needle-loop over the edge, and second loop locked by second thread; 38, two threads, edge of fabric covered by shuttle-thread; 39, third thread laid under the stitch at edge of the fabric.

FANCY STITCHES.—40 to 47. Various of the above described stitches made *zigzag;* 48 to 52, *single-faced* or *straw braid*, *zigzag* or *herring-bone* stitches; 53 to 62, *single-faced* or *straw-braid* stitches; 63 to 67, *embroidering* stitches; 68, *saddlers'* stitch. The sampler stitch is a hand stitch used in Berlin work on canvas or perforated paper. One stitch crosses the other at right angles, forming a small cross.

The Willcox & Gibbs makes the chain stitch; Grover & Baker, the double looped stitch; the Singer, Wheeler & Wilson, Weed, Wilson, Home, Howe, Domestic, Remington and Florence machines, the *lock* stitch.



HIGH SPEED BLOWING ENGINES.

The Lebanon, Pa., *Daily News* of the 4th inst. says:—"The Weimer high speed blowing engine of this furnace," writes Mr. W. P. Ward, the proprietor, "has settled down to a regular working speed of 110 revolutions per minute, and continues to work to a charm." This is undoubtedly the first furnace blowing engine that has ever attained this speed, though even this is not the maximum capacity, as the mate to this engine employed in blowing the cupolas of the Weimer Works is frequently run up to 180 revolutions per minute. It would appear from the above performances that the era of the slow moving blowing engine is at an end, and that hereafter blowing engines, properly constructed, will run as fast as any other class of steam engines.

SULPHUR AND ITS USES.

BY PROF. GEORGE A. KÖNIG.

III.

PROPERTIES OF SULPHUR.—Chemically pure sulphur is a very brittle substance, and its color is a peculiar shade of yellow, called sulphur yellow. Shade and depth of color vary with the temperature; at —50° centigrade it appears nearly colorless. Sulphur is an excellent non-conductor of heat—so much so that a bar of it held between the hands may sometimes crack from unequal expansion. Sulphur acquires strong negative electricity when rubbed; and balls of this substance were used formerly to excite electricity in electric machines. On this account it is very difficult to pulverize sulphur, as the particles attach themselves tenaciously to mortar and pestle.

Sulphur melts at 112° C. to a light-yellow thin liquid. The color becomes deeper with rising temperature, and the fluidity decreases. At 200° C. the color is nearly black, and the vessel may be turned bottom upwards without any sulphur flowing out. The former fluidity returns at from 330° to 340°, but the color remains dark. At 440° C. the liquid sulphur begins to boil, passing off in brown vapors. In heating sulphur above its fusing point, an immersed thermometer is noticed to rise continuously until the mercury reaches 240° to 260° C. Now the mercury remains stationary for some time; then again rises uninterruptedly until ebullition sets in. The same phenomenon takes place when a considerable quantity of sulphur is heated rapidly above 260°. If now removed from the source of heat, the mercury in an immersed thermometer falls to a point between 250° and 260°, where it remains stationary for some time; falls to 210° rather rapidly, very slowly to 175°, again rapidly to 150°, very slowly to 145°, and then uninterruptedly to 112°, when solidification sets in. The stationary temperature in the first instance means that a certain amount of heat is becoming latent, that is, transformed into another form of energy, consumed in changing the molecular structure of the sulphur. For if the molten sulphur at this stage, or above it, be rapidly cooled (by pouring in a thin stream into cold water), it will be found to be a soft amorphous, plastic, and even elastic substance, utterly different from the brittle crystalline sulphur. In this state it is insoluble in carbon bisulphide, a ready solvent for the hard and brittle sulphur. However, by heating

for some time at the boiling point of water, the soft sulphur may be reconverted into the soluble hard sulphur. Of all properties of sulphur, this is perhaps the most interesting in a purely philosophical sense. By a close study of these phenomena, a better key may be found to disclose the relation between chemical force and its mechanical equivalent than by the study of any other body. We recommend it to the attention of chemists and physicists.

Flowers of sulphur—obtained by passing the vapors of boiling sulphur into a chamber containing cold air—is sulphur in a state of dustlike division. It is a mixture of hard and soft sulphur, being only partly soluble in carbon bisulphide. A black, elastic substance, possessing metallic lustre, may be obtained by incorporating into molten sulphur at 180° C. about one-quarter of one per cent. of iodine, and pouring out upon a slab of porcelain or glass. This mass is well fitted to make casts, and deserves consideration at the hands of artists and artisans.

The dark-brown color which soft sulphur exhibits is due to impurities. The least quantity of grease produces a decided color; a touch of a bar of sulphur with the hands, and subsequent melting, will cause coloration. One part of tallow, butter, oil, etc., added to five hundred parts of molten sulphur at its boiling point, produces a black mass when poured into water. One three-thousandth part of tallow yields a ruby-red sulphur by rapid cooling, and fine ruby-red crystals when allowed to cool slowly. Many other organic substances produce a like effect. Molten sulphur does not contract when passing from the liquid into the solid state, hence it may be used to cement and anchor screw bolts into stones, etc.

CHEMICAL PROPERTIES.—Sulphur does not exhibit marked affinity towards other elements at ordinary temperature, except when in the finest state of division. Thus, if precipitated copper (by placing sheet-iron in a solution of blue vitriol) be mixed in a mortar with flowers of sulphur, the two elements combine so rapidly that the disengaged heat is sufficient to raise the temperature of the mixture to red heat. If previously heated and then placed in the vapor of sulphur, or in contact with solid and liquid sulphur, all metals, with the exception of gold, combine with the sulphur in definite ratios. Thus an iron rod, made white in a forge fire and placed against a lump of sulphur, will melt away like butter, the liberated heat being sufficient to maintain the white heat. The result is black *iron sulphide*, containing the two elements in the ratio of 7 iron to 4 sulphur. Reciprocal affinities supplement heat. Thus, the metals in aqueous solution as salts, brought in contact with sulphide of hydrogen or alkaline sulphides, will combine with sulphur at ordinary temperature. In close connection herewith may be mentioned the ready combination of sulphur with metals when the former is in the *nascent* state. (See Part I.) Of inestimable value in analytical chemistry is the strong affinity of sulphur and the metals, and again the much stronger attraction for some against the others. Whilst gold, platinum, silver, mercury, lead, bismuth, copper, tin, cadmium, arsenic and antimony fall out from a solution as sulphides by passing sulphide of hydrogen gas through the liquid, even in presence of a strong acid, zinc, cobalt and nickel are precipitated only from a solution in acetic acid, iron and manganese only in presence of ammonium hydrate or other alkalies. But still within closer limits does this play of affinities move. A solution containing, for instance, silver and copper, the former in very small quantity, precipitates first the silver and then only the copper, when an insufficient quantity of sulphide of hydrogen is added. A most beautiful application of this fact was made in England some time since. The Spanish *pyrite*, now in general use in England as sulphur ores, contain between 3 and 4 per cent. of copper, besides a few thousandths of 1 per cent. of silver, an amount altogether too insignificant to be extracted by any of the usual methods. After the removal of sulphur, the pyrite is converted into red oxide of iron, some undecomposed pyrite, sulphate and oxide of copper, together with the trace of silver. To extract the copper, this pyrite residue is subjected to a second roasting, with the addition of common salt, in a reverberatory furnace, and then extracted with hot water. The solution contains the copper mostly as chloride, but also the silver. It was found possible to concentrate the silver in a comparatively small quantity of sulphide of copper, by partial precipitation with sulphide of hydrogen; and in this concentrated state it could now be subjected to refining processes. Enormous quantities of pyrite being treated in this way, the value of the silver reclaimed is quite considerable, and a handsome profit realized from it. But even without profit, the process would constitute one column in the triumphal arc of applied chemistry. It is very suggestive of many similar losses of metals, hitherto unnoticed or walked by.

Sulphur has a very strong affinity for oxygen (see Part I.), and combines with it in a series of eight well-defined compounds, some of which are of most eminent value in the arts. By direct combination of sulphur and oxygen, however, only one compound has hitherto been produced, the sulphurous acid, now designated as sulphur dioxide, SO_2. When heated in the open air, the vapors of sulphur ignite, burning with a blue flame, and emit the well-known pungent odor of sulphur. This odor is proper to sulphur dioxide. Sulphur is, therefore, a real combustible, a fuel, like carbon and hydrogen:—

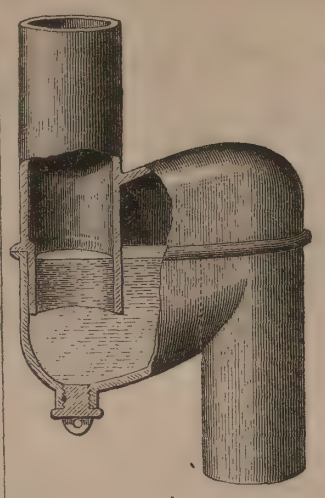
$$C + 2O = CO_2 \text{ (carbon dioxide).}$$
$$2H + O = H_2O \text{ (water).}$$
$$S + 2O = SO_2 \text{ (sulphur dioxide).}$$

Although much below the caloric effect of the two former, the heat of burning sulphur, wasted formerly, is now turned to useful account by the technical chemist. In regions destitute of carbonaceous fuel, the presence of pyrite deposits might even be applied to furnish bodily comfort, if proper care were taken to conduct the products of combustion in the air. The chief use of sulphur as a combustible is made in the manufacture of gunpowder, in pyrotechny generally, and for matches. We shall next turn to the manufacture of sulphur and its applications.

(*To be continued.*)

The Vulcan Iron and Nail Works, Chattanooga, are running double turn and are preparing to push the mills to their utmost capacity. They are making a thousand tons of thirty pound rail for the narrow gauge road from Marietta, Ga., to Ashville, North Carolina.

ADEE'S SEWER TRAP.



We illustrate herewith what is claimed to be a complete preventative of the backing-up of sewer gas. It differs from the ordinary bent pipe trap in having a body some two and a-half times as large as the outlet pipe, which permits of such a weight of water being contained that a much greater pressure of gas is required to lift the water than is necessary to draw air through it. It is apparent from the greater surface of water presented, that this trap will withstand such additional back-pressure over the ordinary trap as shall be in proportion to the excess of their relative areas. A depression of half an inch in the trap would cause a rise of 1¼ inches in the upper pipe, and thus furnish an increased depth of seal. The ordinary depth of seal is one inch. The plug in the bottom permits cleaning when necessary. O. C. W.

DRINKING-WATER AND ITS IMPURITIES.

The intimate connection between the purity of the water-supply and the health of cities and towns has come to be universally recognized in official quarters; and though the legislation upon this subject may not in every instance directly result in the establishment of the proper safeguards against the pollution of the sources of supply, it has, beyond question, been of incalculable benefit in effecting a very general improvement in the sanitary condition of our communities.

The determination of the wholesomeness or unwholesomeness of a sample of water is, however, by no means an easy matter, since taste, smell and color do not always constitute infallible tests of its qualities; for though we may reject, as unfit for use, waters that contain visible impurities, or that possess a disagreeable taste or odor, these are in many cases comparatively harmless compared with others that give no outward indications of danger that may be detected by the senses, but which are, nevertheless, contaminated by those most insidious of poisons, the germs of pestilence and infectious diseases. So that, contradictory as it may appear, a perfectly limpid water, free from disagreeable smell or taste, may be infinitely more dangerous to health than another that is obviously offensive to the eye and disagreeable to the taste and smell. This apparent contradiction, however, does not alter the fact that, in a general sense, a good drinking-water should, *a priori*, be clear to the eye, pleasant to the taste, and free from offensive odor.

Perfectly pure water does not exist in nature, although rain-water is so nearly pure that we may consider it so for all practical purposes; but such are the solvent powers of water that it may be said to take up more or less of every substance with which it comes in contact. Hence it is that water that has penetrated for a considerable distance into the soil and through crevices of the rocks, and subsequently makes its appearance upon the surface in the form of springs, or through artesian wells, &c., is generally more richly charged with mineral matters than the surface-waters of rivers or shallow wells. Such mineral constituents, which commonly consist of the carbonates, sulphates or chlorides of lime, magnesia (iron), soda or potassa, are not to be considered as notably injurious to the health when present in slight quantities, as is generally the case; and were these the only impurities that affected our drinking-water, they might be practically ignored. The surface-waters—lakes, rivers, &c.—from which the water supplies of most cities and towns are obtained, are peculiarly susceptible to quite a different species of contamination, which is productive in many cases of such pernicious results to the health of communities as to have very properly elevated the question of the purity of the water-supply of cities and towns to the first rank amongst sanitary considerations. We refer here to the pollution of rivers, &c., with animal excreta, to the effects of which medical men are unanimous in ascribing the occurrence of typhoid fever, dysenteric epidemics, &c. This is no mere opinion, founded upon the *ipse dixit* of authority, but a strictly legitimate inference from a legion of observations, in which the relation between cause and effect has been ascertained beyond the possibility of a doubt.

In considering the question of the purity of the water-supply of cities, we are confronted with complications of a special character—the refuse of gas-works, dye-houses, the dangers of lead pipes, and the like—but these are altogether of secondary importance when compared with the one above named. It is most fortunate, therefore, considering the almost universal practice which prevails in this country of discharging sewers, laden with the refuse of large communities, into running streams, which further down are drawn upon to supply other cities and towns upon their banks with water, that Nature has herself supplied an efficient remedy for what would otherwise prove to be a most pestilential evil, in that she has given to the rivers the power of self-purification. The running water, by constantly bringing fresh portions of its load of impurities into contact with the atmosphere, rapidly causes its destruction by oxidation, so that a river that has received the sewage of a city will, under most circumstances, be pure enough to drink a few miles below it.

We do not wish to be understood as affirming that the pollution of rivers, &c., with sewage is to be regarded with indifference, for we have always maintained that it was highly uncivilized to waste in such disgraceful fashion vast quantities of matter endowed with fertilizing virtues of the first order, while its utilization does not involve insurmountable difficulties.

Of the artificial means of purifying water, the simplest and best is filtration, which is in some places carried out on a grand scale by means of beds or reservoirs provided with porous partitions, or so arranged as to oblige the water to percolate in succession through a variety of cleansing materials. By means of such devices all suspended impurities, such as mud, animal and vegetable substances, &c., are strained out, and such devices are held in deservedly high estimation. W.

—The Loomis Nut-Lock Washer Company has shipped 25,000 of its washers to the New York Central Railroad.

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

HOW WE ANALYZE.

BY HENRY PEMBERTON, JR.

It is one of the striking characteristics of a scientific man, that his ideas, thoughts and language are shrouded in mystery and enveloped in an atmosphere perfectly impenetrable to the general public and the general reader. Language most certainly was given him to disguise his thoughts. "Science," says a witty writer, "is everything you can't comprehend; directly you begin to understand it, it ceases to be science."

The popular idea of a chemical laboratory is a rather vague mixture of crucibles, stills, balances, mysterious glassware, and diabolical smells. The general idea of chemical literature is that it is brilliantly lacking in amusement, entertainment, and euphonious terms. The general idea of an analytical chemist is that of a secluded individual, absorbed in the aforesaid laboratory, devoted to the above-mentioned apparatus, or buried in that fascinating literature.

To do justice to this much-injured man, and at the same time to give our readers a popular *resumé* of the *modus operandi* of an analysis, is the purpose of the present article.

If we should give a savage a mixture of iron and copper filings, he could, with sufficient patience, make a complete separation of the two metals on account of their difference in *color*. A civilized person could avoid the tedious separation, grain by grain, and yet obtain the same result by making use of their different behavior towards the *magnet*. Whilst a chemist (still a grade higher) could make the determinations most accurately of all by the proper *chemical* treatment in the laboratory. What we wish to illustrate is, that it is by the superior knowledge of the *properties* of various bodies that we obtain the most accurate results. It is only by their properties that we are able to know them, and it is this knowledge which gives us the power to analyze and examine them. In fact the experience of every-day life will enable any one to do a certain amount of chemical analysis. Suppose the reader has reason to doubt the purity of the sugar his grocer sells him, and wishes to determine the amount of sand present therein; he could test the same by availing himself of the solubility of sugar and the insolubility of sand in water, and might state his results, let us say, thus:

Sand	18
Sugar	82
	100

That is to say, that 18 per cent. of his sugar is sand—an atrocious swindle on the part of the grocer. The above method of stating results, by-the-by, might answer provided we merely wished to make ourselves intelligible; but in order to endow our "report" with the orthodox incomprehensibility as well as the impressive accuracy of scientific work, it would be better to put it—

Silicic anhydride [SiO_2]	18,000
Saccharose [$C_{12}H_{22}O_{11}$]	82,000
	100,000

But it is evident that all analyses are not made on such simple mixtures as copper and iron, sugar and sand. In order, therefore, to give a more general view of the subject, without going into tiresome particulars, we will divide the description into five parts, since the field is such a large one that we could not give a clear idea of it otherwise.

I. "*Gravimetric Wet Analysis.*" The most universal, important, and accurate form of analyzing that the chemist has at his disposal. We say "gravimetric," because the determinations are made by *weighing*, in distinction from *measuring*, as in "volumetric," and "wet," because the reactions and separations are made by having the substances in *solution*, in distinction from where they are separated in the *solid* or molten state, as in "assaying."

With the exception of most organic bodies and some gases, almost everything that *can* be analyzed will come under this first division—all metals, all minerals, all mineral products, ores, articles of commerce and manufacture, in addition to a number of organic substances and many gases. The general method of procedure is of first obtaining the substance in solution, either by means of water or acids, or by first fluxing and then dissolving in the proper solvents, and then adding the requisite chemicals that will form *insoluble* compounds with one or more of the dissolved salts—this insoluble compound being called a "precipitate," which can be filtered off from the remaining substances that are still in solution and weighed, whilst the "filtrate," or part that filters through, is similarly treated with other chemicals.

Suppose we wish to know the amount of silver in a ten-cent piece. The entire coin, or a fraction of it—whichever we choose—is dissolved. By referring to our manuals, we find that "nitric acid" is the best solvent for silver and for copper, the two metals under treatment. Accordingly we treat the accurately weighed sample with this acid, and obtain a light-blue, perfectly clear solution, containing *all* of the silver and copper. We next look to see—or rather, if we are a chemist, we *know* that already—what substance will form an insoluble compound with one of the metals without affecting the other. These conditions are satisfied by the fact that "chloride of silver" is *not* soluble in water or dilute acids, whilst "chloride of copper" *is* perfectly soluble in the same. So we add a compound containing chlorine—best, hydrochloric acid—and filter off the chloride of silver, wash and weigh it, from which we can easily calculate the amount of metallic silver, since all of these compounds have a fixed and definite composition. We would find that our ten-cent piece is 90 per cent. pure silver.

II. "*Volumetric Analysis.*" Here also we have to deal with solutions, but the "reagents"—*i. e.*, the chemicals applied in testing—are *measured* from a graduated tube, called a "burette," until their effect is, so to speak, neutralized, or, as the chemist would say, until "the reaction is finished," the end of the reaction being shown sometimes by the color, sometimes by the "precipitate" no longer forming. From the number of burette divisions we calculate the percentage sought for. It is a peculiarity of "volumetric" analysis that whenever we determine any substance, we invariably do so by determining something else. Thus, to find the percentage of iron in an ore in this way, we would not under any circumstances whatever determine the iron itself, but would carefully standardize the strength of the liquid in the burette, and so calculate the iron.

Volumetric analysis is quick and generally accurate, and, although not by any means of universal application, is, especially in chemical works and for commercial products, invaluable.

III. "*Assaying*" is the oldest of all forms of analysis, and generally the simplest. It is applied more particularly to the examination of ores. The ore is generally fused with a proper flux and some easily-melted metal; the flux unites with the "gangue" or earthy parts of the ore, whilst the metallic portions fuse together and separate into a button or "regulus." This is afterwards treated so as to separate it from the metal previously added, and a very pretty sight indeed it is to see the little globule growing smaller and smaller as it is gradually freed from the base metal, and finally yield the pure silver, copper, or gold, as the case may be. In a somewhat different manner are treated lead, bismuth, tin, iron, cobalt, and nickel. The results are not extremely accurate, although more so than the yield on the metallurgical scale; and as the time required is not long, and the apparatus of a somewhat "alchemic" simplicity, assaying has advantages peculiar to no other form of analysis.

IV. "*Organic Analysis*" is the analysis of organic bodies—*i. e.*, those composed chiefly of carbon, hydrogen, and oxygen, in contradistinction to mineral substances. Organic analysis is either "ultimate" or "proximate." An ultimate analysis is the determination of the simple elements, as when we determine the percentage of carbon, hydrogen, and oxygen in sugar, for example. It is made by burning the substance in the proper apparatus, and absorbing the products of combustion in the proper absorbents. The processes are accurate and quick, and the subject has been exhaustively studied.

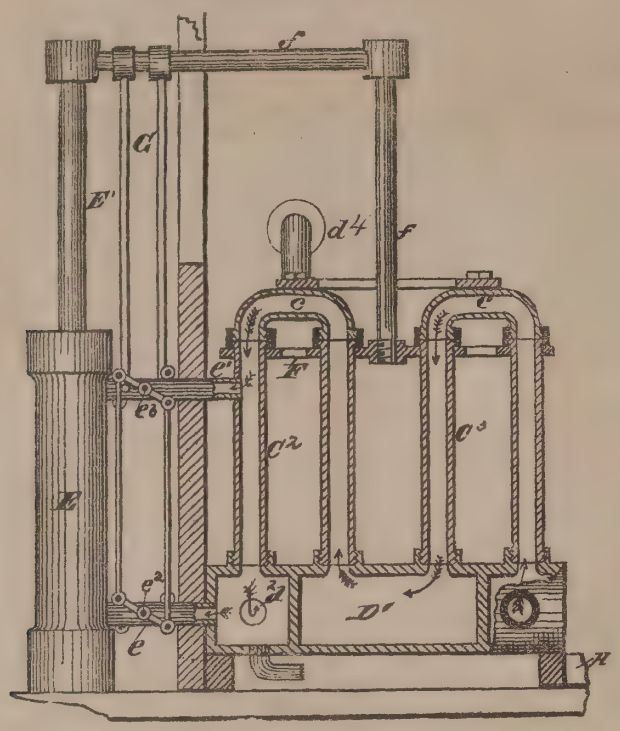
A proximate analysis is made when we separate one body or compound substance from another without going into the elementary composition of either, as when we separate one oil from another, or, as in the case of our friend the grocer, sugar from sand, &c. The separations are sometimes exact, frequently approximate, and very often are entirely wanting—that is to say, some bodies cannot be separated from others. It may be observed here that throughout analytical chemistry in general it is the "separations" that are most difficult, as the subsequent "determinations" are generally easy enough. Organic chemistry is the widest, "newest," but least advanced field of all chemistry, except, maybe, physiological chemistry.

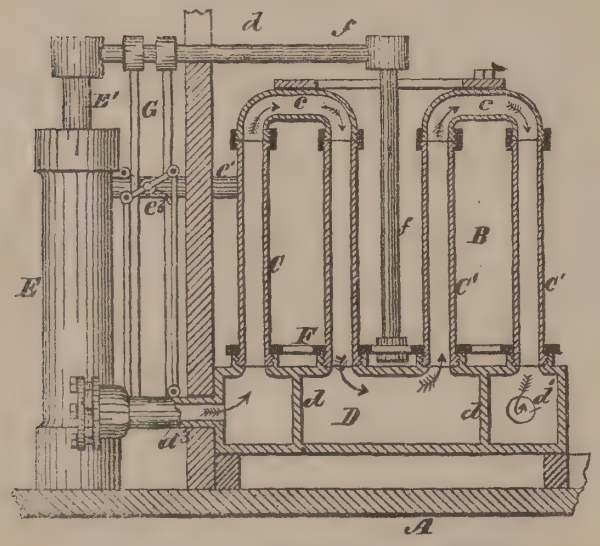
V. "*Gas Analysis*"—a branch of analysis developed by the chemist Bunsen. Some gases are absorbed by certain solids, and so determined—either over mercury, in graduated tubes, when they are *measured*, or in flasks and other glass apparatus, as proposed by Henry Wurtz, when they are *weighed;* or, thirdly, some gases can be determined by exploding with oxygen or hydrogen, and from the subsequent contraction their composition calculated. The subject is of much practical importance in connection with gases from blast furnaces, gas wells, &c., &c. It is a curious and interesting thought that six or eight separate and distinct compounds can be determined correctly to the tenth of one per cent.—as the writer has often seen done—from a small tube full of gases, which are perfectly invisible, and which cannot possibly be perceived by any of the senses.

Such is a bird's-eye view of the field of knowledge and work which comes under the province of an analytical chemist. Even from the small sketch here given it can be seen that the amount of time, study, and training necessary for a chemist to become proficient in his profession is not surpassed by that required by a student in any other profession, be it either law or medicine; for if the doctor or the lawyer require much study and preparatory training, so also does the chemist. The physical sci-

ences, physics, geology, and mineralogy, of which we have said nothing in this article, are alone of much more importance to him than are the classics to the lawyer or any like preparatory education to the doctor. And it can be seen what a tax upon his ability it is, when in addition to his specialty—his profession—he is expected to be an authority upon almost every outside subject in the arts and sciences, as is the case in the often-raised cry for a "practical man."

It is but natural, then, that the analyst, and more particularly the original investigator, whose entire life is spent within the quiet walls of the laboratory, and who receives little else from his work than the pleasure and reputation yielded him,—it is but natural that he should feel proud and gratified at his position—one of the leaders of the science that has held the most prominent position of all sciences in advancing the civilization of the present day.





THE SHUSTER FUEL ECONOMIZER.

We have had such frequent occasion, especially within the past few months, to recur to the great loss which occurs in the generation of steam, by reason of the high temperature of the escaping gases of combustion,* and to the increase in generative capacity, or saving in fuel consequent upon heating the feed water,† that any extended remarks upon the subject would be unnecessary; suffice it to recall under the first head that the ordinary generators require the combustion of $\frac{1}{8}$ lb. of coal to evaporate 1 lb. of water, when $\frac{1}{12}$ would be ample if combustion was thorough, and the heating surface ample in size and properly arranged. The saving in fuel effected by heating the feed water from 60° to 212° F., is variously estimated at from 10 to 15 per cent.

The question of imperfect combustion is recently being undertaken, with a view to betterment, by heating the natural *draft* with results approaching, in some instances, that gained by heating the feed water. This principle of hot-air supply, already applied with marked success in the hot blast stove,§ may be applied to boilers alone, or in conjunction with that of heating the water supply. If we can gain 10 per cent. in fuel by a forced hot-air feed, and 10 per cent. on the 90 by moderately heating the feed water by means of the exhaust, we have a total of 19 per cent. gross profit; or in other words, we burn but 81 lbs. of coal, instead of 100, to produce a given amount of steam, and our waste by the cold air and cold water supply was $\frac{19}{81}$, or 23.45 per cent. over the consumption under improved conditions; 100 lbs. of coal, with hot draft, will evaporate as much water, with hot feed, as 123.45 lbs. of coal did with cold draught, and moderately cold feed. Referring again to the hot blast stove, we remember that the old blast furnaces discharged their gases, highly heated, into the air without utilizing them; later, these gases were employed to generate steam, but were greatly in excess of the demand; and still later the excess was employed to heat the air blast, with a marked result in economy and improved quality of product.

We have, in the ordinary steam boiler, the same wasteful conditions in kind, if not in degree, as obtained in the old days of blast furnaces; highly heated gases escaping unused, and bearing away with them a large percentage of what should be the profits of the establishment permitting such waste.

Records of boiler tests before us show a temperature of chimney gases of 600° F. Now there is no more heat required in the chimney than enough to hold the gases at such a degree of rarefaction as to render them enough lighter than the cold outside air, to cause their ascent between the slightly retarding walls of the chimney.

Where the setting will permit it, we should employ these highly heated chimney gases in some useful and profitable work. A field for such work is offered in the heating of the feed-water to a point beyond that attainable by means of the exhaust.

The cuts illustrate (somewhat crudely it must be admitted) the salient features of a device calculated to produce a marked economy in fuel, by heating the feed water, as suggested, to a higher temperature than is attainable by means of the exhaust steam.

It consists of a series of cast-iron sections, each having two inverted U's (4″ diam. $\frac{1}{2}$″ thick) communicating with a partitioned base piece; the base pieces being connected by faced joints.‡ A suitable number of these sections (they hold 50 gallons each) being placed in a suitable chamber, between the boiler and the chimney, the feed water is forced through the system in a direction from the chimney towards the boiler, encountering hotter gases as it passes onward. It can readily be seen that gases, escaping in large volumes at a temperature of 600° in the chimney are capable of heating the contents of the system of pipes to a very high degree.

The temperature of the chimney gases ought not to be more than 100° F. higher than that of the steam; the temperature corresponding to 75 lbs. pressure is about 308°, which would not permit of more than 408° for the chimney.

If we give a heating surface of much more than 36 times the grate, we might reduce the temperature of the chimney gases below that of the steam; but the water evaporated per pound of combustible will be less than with smaller proportions of heating surface, as there is heat conducted from the water into the flues.

The object of the Shuster Economizer is to reduce the chimney temperatures from the excessive degree generally found, to that barely necessary to cause the proper draft; the entering feed water absorbing that excess, through metal surfaces kept clean by suitable scrapers; easily accessible, devoid of joints exposed to the action of the fire. The circulation being forced, feed water at a temperature of over 212° may be fed to the boiler. Any sediment should be deposited in the base, to be removed by a blow-off cock.

We may say, roughly, that the gain by heating feed water is about one per cent. for every ten degrees of temperature, thus in heating from 60° to 260°, as is frequently done by means of the gases of combustion, the saving should be $\frac{260-60}{10}$—20 per cent. Some claim one per cent. for every 8½ degrees, which would make the saving higher.

G.

Vide this journal, iii, 145, 253.

†See vol. iii, pages 194, 202.

‡The cuts, taken from the Patent Office drawings, show flange joints at the bends of the U's. As now made, each U is cast in one piece.

§ See illustrated article on the Progress of Hot Blast, page 315, current volume.

WHY CIRCULAR SAWS BREAK.

The following points are taken mainly from Messrs. Disston & Sons' "Lumbermen's Hand Book."

Makers are annoyed by having saws returned for repair in such a condition that it is impossible they should go through the wood, from the miserable way in which they have been filed and set—some jammed all to pieces, some not half filed, some not filed true on the face or back, while others are all shapes but the right one in the throat, leaving no chamber-room for dust or chips. Some saws have a bad pitch, some no pitch at all; some out of round; some with irregular or long and short teeth, one up and one down. In many cases they are returned broken, as shown at D. Why? Each tooth of a 24-inch circular saw goes through the wood 2000 times per minute, 120,000 times per hour, 1,200,000 times per day, and if not sharp, the saw is strained at the root of the tooth thus often, which frequently not only closes the set, but must eventually break the saw; for although steel is strong, continual straining will make it tender, and it must break.

Point C represents the condition the tooth should be in for work. Point B is dull, and from such cause results a great deal of breakage. The tooth becomes dull on the side or under the point in proportion to the amount of feed; thus, if the tooth takes $\frac{1}{8}$ inch hold at each revolution, it will become dull for $\frac{1}{8}$ inch below the point, or more if the feed be greater.

A diamond will not cut if dull; why should a saw? A few minutes filing two or three times a day would save ten-fold the amount of time and labor expended in running an imperfect dull saw, also making a saving in the amount of power consumed, and a heavy percentage in the quantity and quality of lumber cut. It is a mistaken idea that there is a saving by not taking time to sharpen a saw. If it were a razor, and the man that works it obliged to shave with it, it would be kept sharp. It is quite as essential that a saw be sharp, as a razor or plane, or any other cutting instrument; and when proud, or full and sharp, it does not require one half the set or power on the same feed.

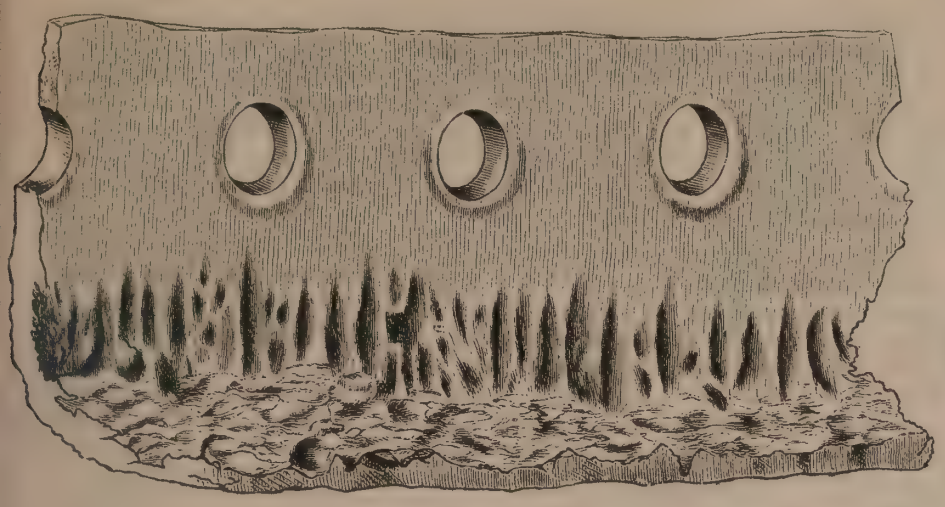


Fig. 6.

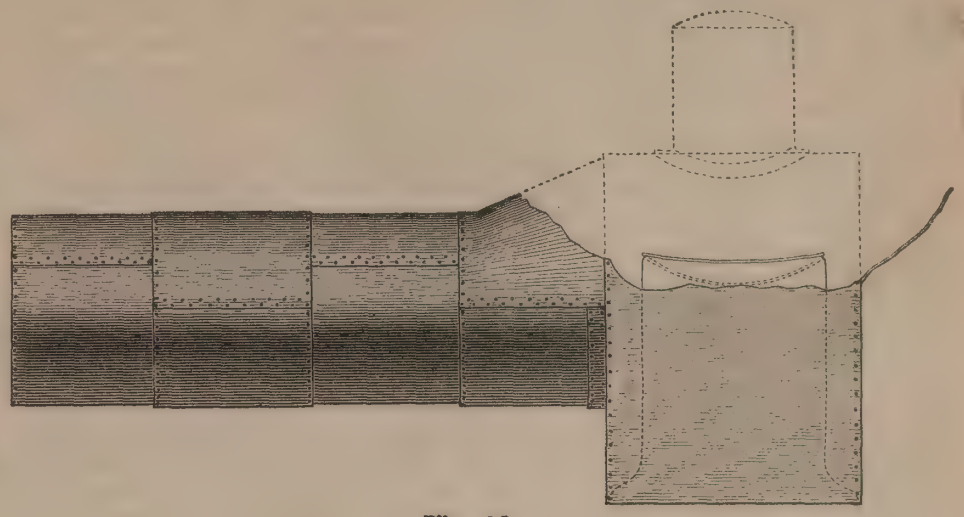


Fig. 10.

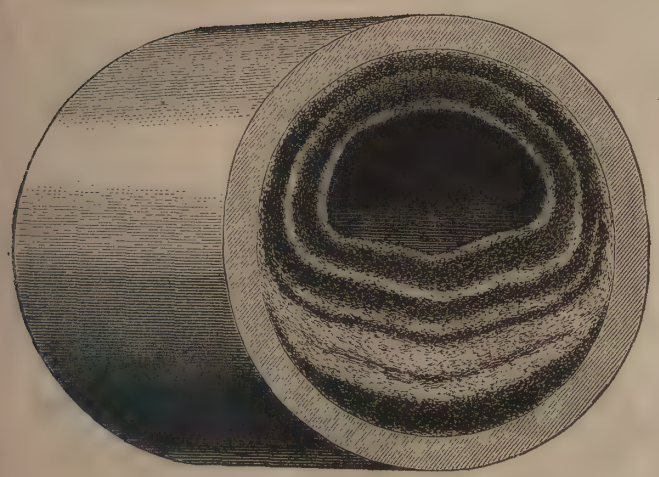


Fig. 7.

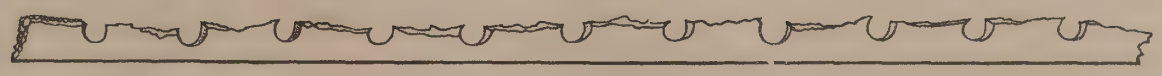


Fig 8.

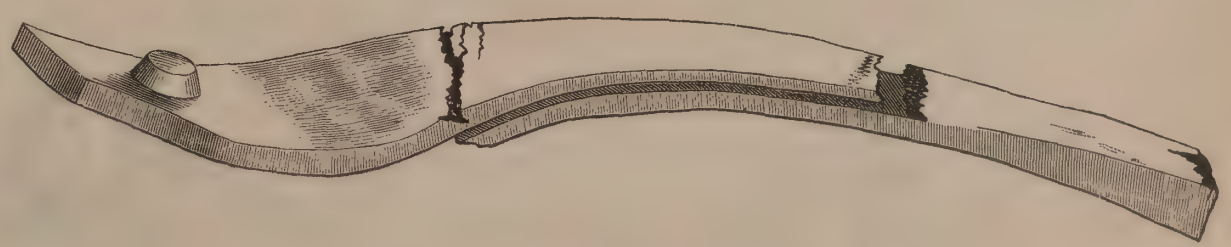


Fig. 9.

ANNUAL REPORT OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

II.

Referring again to *internal corrosion*. There is a difficulty belonging to this class of defects, which is often met with, but which is more frequently called "pitting." That is, instead of the plate being worn away with comparative uniformity, it is attacked in spots of greater or less size; sometimes in small round holes, distinct and separate from each other, then again in large areas, connecting and running together. This trouble has been found in many parts of not only this country, but in England, France, Germany, and Austria. We have a photograph of a plate which was taken from a boiler in Wales. The inner surface of the plate looks as though it had been cut and bruised with a dull tool. At the time this was discovered (some twelve years ago), considerable discussion arose in various parts of Europe and America as to its cause, but until within a few years no definite cause was assigned. It was said to be a peculiar case of incrustation. The business of making guaranteed steam boiler inspections, has met with much favor among the manufacturers of most parts of the United States and Europe, and through the work of these institutions much light has been brought to bear upon the defects found in steam boilers, and the causes and prevention of boiler explosions.

These organizations having a direct and pecuniary interest in understanding such difficulties, have given much time, expense, and patient labor to their investigation. As a result, the question of *internal corrosion* has received particular attention, and the direct cause of most cases has been ascertained, and the remedies prescribed. In the former reports of this company, the subject has been quite fully discussed. It is now pretty well settled that the pitting of boiler plates, particularly when the defect is confined to some one or two plates only in the boiler, is caused by galvanic action.

Iron from different beds of ore is found to be not chemically the same, and strange as it may seem to those not familiar with the subject, ore from the same mine is not always chemically uniform. This being the case, it will be seen that iron made from different ores will be chemically different, or their electro-condition will differ more or less. In some cases the difference will be so slight, that with good feed-water, and proper attention to *feeding and blowing*, together with good care and frequent cleaning of boilers, little or no difficulty will be experienced. While on the other hand, with impure water, and indifferent boiler care, much trouble may be experienced.

Experiments made with pieces of iron cut from plates which were *pitted*, and from those which were not—taken from the same boiler, and placed in a bath of acidulated water, and connected with a galvanometer, resulted in the production of a current. The purer iron corroded. It may be a question with some as to whether these same conditions would occur in a steam boiler in use. I am prepared to say that I think they would.

These peculiar cases of pitting are almost invariably confined to localities where the water is not of the best quality. The difficulty is much enhanced if the boiler has indifferent care. In case of impure water, the boiler should be frequently *blown out*, and cleaned. The feed-water used at mines and iron works is often of the worst quality; so also is that taken from streams into which factories above discharged their spent dyes and refuse. Fig. 6 illustrates a case of peculiar corrosion which we found in a boiler fed by *swamp water*. This piece, which can be seen in this office, is a fair sample of the entire head of the boiler in question, and one other plate which was nearly as bad.

We are favored with the report of the "*Association pour la Surveillance des Chaudieres a Vapeur*," for 1875, in which are some very interesting illustrations of this peculiar type of corrosion.

The cases of *internal grooving* with which we have met during the past year, were 164, of which 59 were regarded as dangerous. This defect is developed by too rigid staying and impure water. It has been fully discussed in former reports.

Out of 2,894 cases of *incrustation and scale*, 392 were regarded as dangerous.

This difficulty is very common, and is occasioned by impure water. To the casual observer the water may appear sparkling, limpid, and free from all deleterious substances, but when subjected to heat the various sulphates and carbonates are thrown down, and often form a very troublesome scale. The difficulty is liable to extend to the feed pipe.

We have found instances where a perforated pipe extending into the boiler was used for discharging the feed-water, and around the perforations were hollow cones of incrustation, sometimes two or three inches long. Oftentimes these holes become stopped up entirely, obstructing the flow of feed water. These difficulties occur in districts where the water is strongly impregnated with lime.

Fig. 7 shows a piece of feed pipe in our possession which, as will be seen, is nearly filled with incrustation.

Great care should be used in selecting a preparation to remove or aid in removing scale from boilers. There are a great many "boiler purgers," and "anti-incrustators," in the market, some of which are very beneficial, while others are injurious and dangerous to use. If the steam user is not conversant with the chemical nature of the composition proposed, he should seek advice from some competent person before using it.

The cases of *fracture in plates and other parts of boilers* coming under our observation have been 1,199—590 of which called for special attention.

The old difficulties of careless firing, faulty construction, poor iron, and overstraining are the causes.

Fractures are often found in the line of rivets, from hole to hole, as in Fig. 8. This defect being usually confined to the inner lap of the sheet, cannot be detected from the outside. Boilers often appear perfectly sound from an external examination,

when an internal examination reveals defects that place the boiler in a dangerous condition, as will be seen by the following illustration.

Braces are not only corroded, as in Fig. 4, but are frequently found broken and useless for the purposes intended. Poor iron, bad welding, and poor workmanship are causes of such defects. Every brace is calculated to bear a certain strain when the boiler is under pressure, and if, from the causes above named, it becomes useless, the calculated strength of the boiler is thereby much reduced. Fig. 9 shows part of a brace which was taken from a boiler which we were called to inspect. A portion of the lower foot is gone. The brace was of no use whatever.

Uneqnal expansion and contraction is the primary cause of many of most of the fractures in steam boilers; therefore, in addition to the best of care, boilers should be constructed of the best material, and the workmanship should be first-class in every particular. It is poor economy to employ an irresponsible man to construct a boiler because he will do it for less than the average price of well-known firms. The number of *broken braces and stays* coming under special attention the past year was 415, of which 243 were in dangerous condition.

Pressure gauges out of order 1,658—411 dangerous. The variation in these dangerous cases from the standard was from —32 to + 65. These figures indicate the extremes. Pressure gauges should be periodically compared with a gauge known to be correct, for to run a boiler with an unreliable gauge is like navigating a ship with unreliable compass. It is needless to add that both are dangerous. We are often astonished to find people running boilers without any steam gauge, or any means of ascertaining the pressure, save by the safety valve. (We did once find a man who claimed he could tell the pressure by the sound the steam made in issuing from the gauge cock.) Their argument is that steam gauges are of comparatively recent invention, and that the early steam users got along without them. Very true; but boilers were used by the early steam users at very low pressures, seldom but a few pounds in excess of atmospheric pressure, while now high pressure is the rule. We have found 536 instances of boilers being used without gauges. The boilers in 9 of these cases were run at such high pressures that we considered them dangerous.

The number of boilers *condemned as unsafe to use was* 89. While no honest man would wish to run a dangerous boiler, in times of business depression, such as have been experienced the past eighteen months, steam users, to avoid expense, have, no doubt, in some instances, preferred not to know what condition their boilers were in. When a man is pressed on every hand, hoping for some fortunate turn in his affairs that will save him from impending financial ruin, he is not in condition to attend to the details of his business with that scrutinizing care that is manifested in prosperous days.

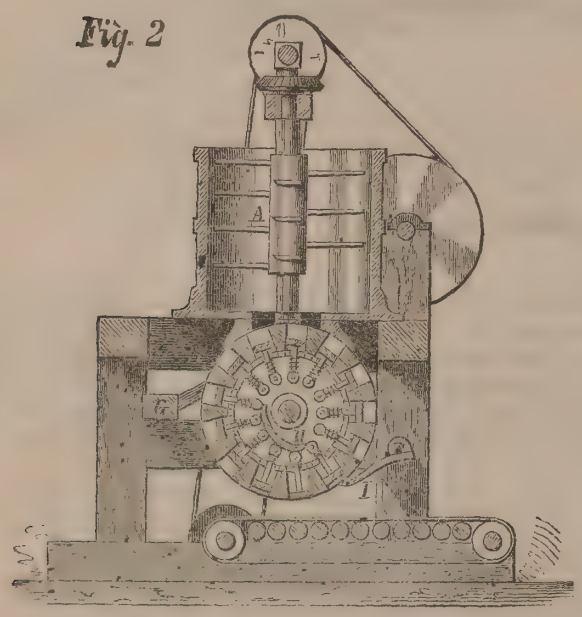
Hence the machinery, engines, and boilers are liable to be neglected, or from standing idle, without proper care, deteriorate rapidly. The main points of our business during the past year have now been gone over, and it will be seen that boilers, like everything material, grow weak and old, and must be patched and repaired, or thrown aside altogether. This being the case, the only way to prolong their lives is to give them proper care. When small defects develope, give them early attention. Have repairs made at once by a competent person. Pursue this course and boilers will last much longer than the majority do now

EXPLOSIONS.— From the record of boiler explosions, kept in this office, we make up the following classification. It should be understood that the small "bursts" and "breaks" which are continually occurring to boilers are not included here. These cases are all bad explosions. The whole number of boilers exploding was 111, by which 154 people were killed and 167 wounded. Some of the latter were reported as probably fatally wounded. In saw mills, planing mills, and wood working establishments there were 27 explosions; steamboats and tugs, 11; portable and coal mine boilers, 10; locomotiver, 6; boilers for heating, 6; woolen mills, 5; iron works and rolling mills, 4; threshing machines, 4; cotton mills, 3; bleach boilers and kiers, 3; paper mills, 2; machine shops, 2; white lead warks, 1; miscellaneous, 11. Some of these cases received special attention, and sketches of the exploded boilers were obtained. In other instances the accidents were so remote that few particulars could be obtained. Fig. 10 is an illustration of a boiler used on a steamboat in the West, which exploded July 3d. It was a second-hand boiler and was run at a pressure of 115 lbs. per square inch. The boiler was made of $\frac{3}{16}$ iron, crownsheet not braced. One man was killed, and one seriously wounded.

This boat was to have taken an excursion up the river the following day, July 4th. The loss of life would have been very great had the accident occurred one day later. It will be seen that the pressure was excessive and the boiler was doubtless much worn and weakened.

(To be continued.)

Fig. 2



BRICKS AND BRICK MAKING.—XXI.

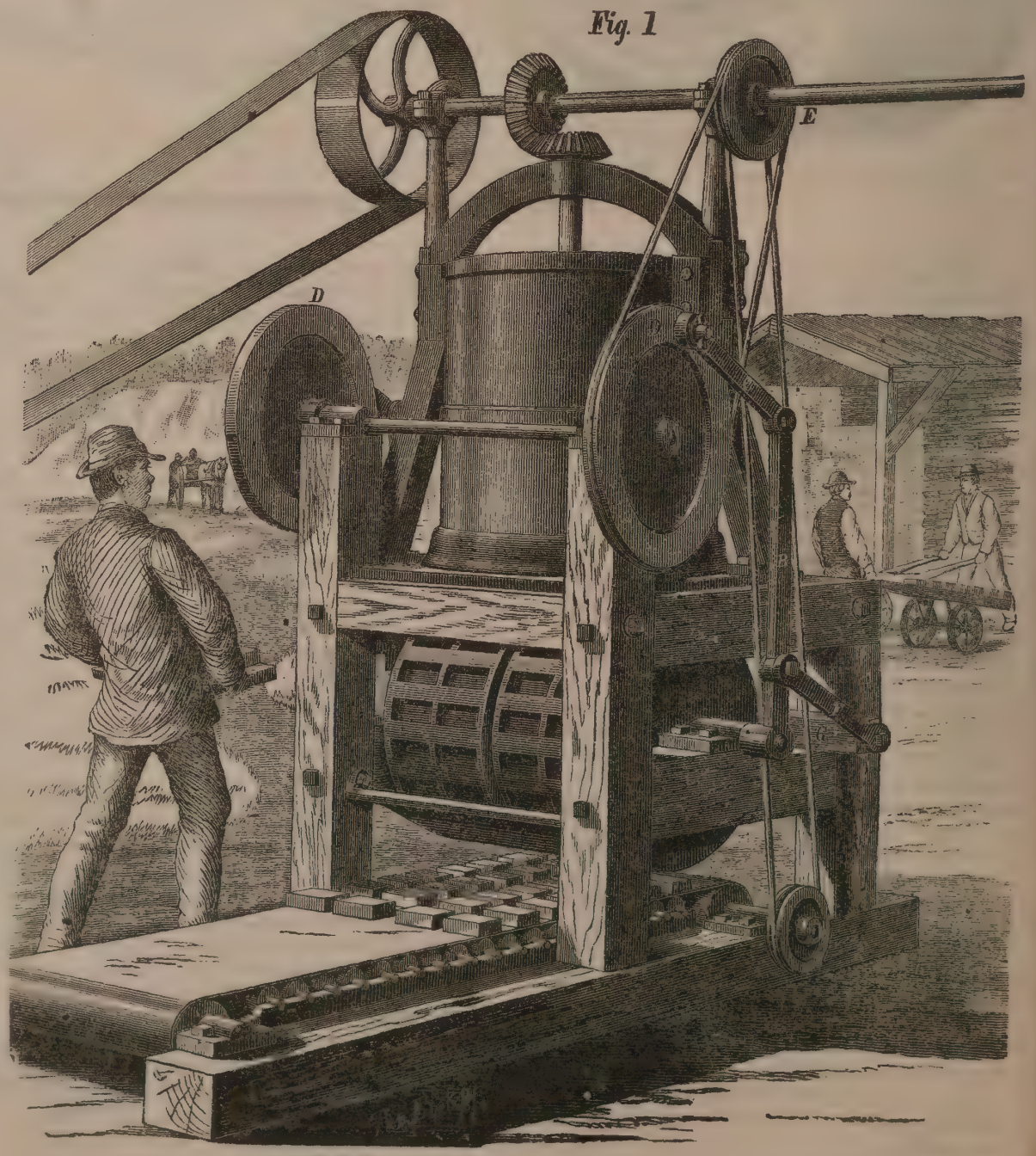
THE MACHEN BRICK MACHINE.

The cuts herewith show a form of brick machine* in which the moulds are in the periphery of a horizontal cylinder rotating beneath a vertical pug mill. The bottoms of the moulds are plungers having springs on their stems and actuated by a fixed cam H playing against rollers on the ends of the stems. The upper moulds being filled by the wipers of the pug-mill (while the plungers are drawn in by their springs) the cylinder is then given a partial rotation. The bricks are borne off by an endless belt. G.

*Made by W. H. & H. P. L. Machen Jr., Toledo, O.

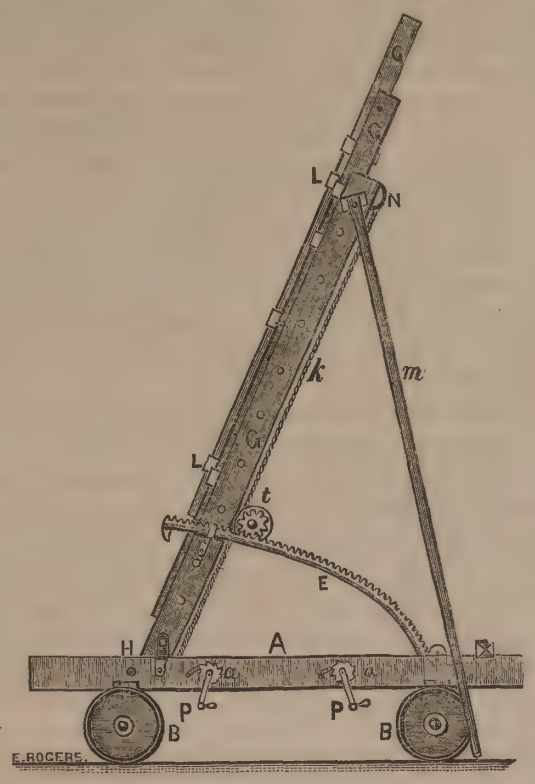
—The Health Committee of Glasgow, says the *Analyst*, seems to be going rather ahead of the sanitary boards of other cities, and we think very wisely so. They are carrying on continuous observations, at different stations in the city, on the variations in the composition of the air, and have expended a considerable sum of money in fitting up a laboratory in order to determine the variations which occur from time to time in the composition of the atmosphere itself, and the character of the floating particles which are present in it. The committee certainly deserve the utmost credit for taking a step so far in advance of any which has been taken by any ordinary public body.

Fig. 1



IMPROVEMENT IN FIRE ESCAPE LADDERS.

Patented January 26th, 1875, by MORGAN DAVIS, of Covington, Indiana.



The object is to arrange the different sections of ladders on a carriage in such a manner that they can be quickly elevated and extended without changing the position of the wheels; there is a novelty also in the manner of strengthening the side rails of the ladders. The engraving represents a side elevation, with the ladder elevated and braced. A represents the frame of the carriage bed, and is supported upon two pairs of wheels, B, in the ordinary manner, except that both sets of wheels have a fifth wheel, so that either end of the carriage can be moved, as desired. H represents a bolt or bar passing through the sides A, on which is pivoted the end of the ladder G. The racks E are so pivoted that they can be elevated, as shown in engraving, and held in proper position by the braces; and if the braces are taken out of their sockets on the frames A the racks E can be lowered; or the racks E may be stationary, as shown in the engraving. *t* represents a wooden roller or pulley, with a shaft passing through it from end to end, and extending out from each end far enough to receive the pinions. These pinions work in the racks E. Between these pinions and the main pulley *t* are rollers, that the under sides of the rails of the ladder G slide on as it is elevated. At the top of the ladder G, and extending across with suitable bearings, is a shaft, on each end of which, and just inside of the ladder, are two pulleys. *a* represents the windlass that is used to elevate the ladder L from the position shown.

The operators revolve the windlass *a* by means of the cranks P, and as the ropes *k* (which pass under idle pulleys on the pivot road H) commence to wind up on the windlass *a* they commence to unroll from the pulley *t*, and communicate motion to the pinions, which commence to work upon the circular racks E, and, as they advance, the rollers between the pinions and pulley *t*, slide along under the side rails of the ladder G, and elevate it to any desired position, as shown in engraving; then the pawl is placed against the ratchet, and the ladders are stationary, after which the braces *m*, which are hung with a swivel, at N, at the top of the ladder G, are braced to hold the ladders firm. The ropes are secured to the windlass, and extend from the windlass to the pulleys on the pivot-shaft H, and pass around the pulleys and under the rounds of the ladder G, and are then carried upward and around the pulleys at the upper end of the ladder G, and after passing around the pulleys, are carried down between the rails and above the rounds of the ladder G, and are secured near the bottom, on the side rails of the ladder. Immediately under the shaft that has the pulleys attached is a bar extending across from rail to rail, and on this bar is fastened one end of the rope *k*, which continues upward and passes over the pulley at the top of section, and then downward under the rounds of the ladder and made fast near the bottom. After the ladders have been elevated, as shown by engraving, the operators then go to the crank P, on the windlass or pulley, and as it is revolved, the ropes commence to wind up on the pulley, and the section of the ladders commences to raise in the slides. At the same time the rope, by its connections, commences to elevate the ladders, and the ladders can be extended to any desired height, and held there by the pawls engaging with the ratchet. On the sides of the ladders, as they are extended, can be placed a spring catch, so arranged as to hold the ladders against any accident to the ratchet and pawl (by which they would become disengaged); and this catch can be drawn out by a line when it is required to lower the ladders. After the ladders have been extended, and the carriage adjusted, so that the ends of the ladders are in their proper place, then the extension bars are extended across the front of the ladders, having their support on or through the bed or sides, and the braces, which are hinged to the ends of the extension bar, are braced against the ground, and the whole mechanism is held firm and stationary. If more steadiness is required, then guy-ropes can be used.

THE BEET ROOT SUGAR INDUSTRY.

BY LEA PUSEY.

The principal object of this writing is not alone to merely report the results of some imperfect experiments, but to draw the attention of Americans to one of the most remarkable vegetables of modern times, that greater, more extended, and more thorough efforts may be made to cultivate it; a vegetable, a root, two-thirds of the solid part of which is sugar, and whose value to nations and people of the Temperate Zones cannot be magnified beyond its merits. It is especially needed by this nation to restore its prosperity, and establish that prosperity on a more permanent basis. It is the child of modern scientific cultivation and skill, is the foundation of an improved agriculture in Continental Europe, the basis of a great industry, which has contributed an important part in the recent surprising financial strength of France, and no nation appreciates its virtues more. Enthusiastic French writers speak of it as "that precious plant," "It saved the country from famine twice in fifteen years," "It is one of the most important elements of public prosperity, rendering to modern society the greatest services, at the same time it attains for itself the highest point of prosperity and glory to which any industry ever had the ambition to aspire," "Everybody sings its praises," "It says in deeds, I compel industry by the richness of my reward," "I multiply the centres of labor, and give employment to people who would otherwise be idle," "I solve one of the greatest problems of modern society: I recognize and elevate labor and give prosperity to the nation, which is the basis of public order," "Make me a bed in congenial soil, mellow and deep, protect me from enemies, keep my body covered from the piercing rays of the summer sun, and in the silent darkness I will transmute the crude materials of earth and richly repay your care."

A BRIEF HISTORICAL SKETCH OF ITS DISCOVERY, GROWTH, AND PRESENT EXTENT IN EUROPE.

In 1747 Margraff, a Prussian chemist, discovered that sugar was contained in the beets, in such quantity that he advised his countrymen to cultivate them for the purpose of making sugar, but no attempt was made to utilize the discovery until 1773, and that failed.

In 1799 sugar was first successfully manufactured in quantity from the beet, and several loaves were presented to the King of Prussia, under whose patronage it was produced. A report of this result was published, and attracted great attention, especially in France, where a committee of the most distinguished chemists appointed by the Institute reported that the amount of sugar was rather less than one per cent. Nothing further was done until in 1810, when Napoleon I. had a new committee appointed. This resulted in the production of about one and a half per cent. of sugar, equal in every respect to the cane sugar. In 1812 the French Government took an active part in inaugurating this industry, and it may be considered as the period at which it was placed on a foundation that secured its ultimate permanent establishment; 100,000 acres were planted in sugar beets by order of the Government, and 1,000,000 francs were used to stimulate the enterprise. The fall of Napoleon in 1814 caused the failure of all these factories except one, and it was not until the imposition of high protective duties on foreign sugar that they recovered. From that time they slowly increased, and the same policy produced the same results in other European countries, but England, adhering to a different one, is without this industry and now, as a result of the continued protection of it by her European neighbors, the home competition amongst them, with the great improvements made, have reduced the cost so that the refined beet sugar is now sold in the English markets in competition with the cane, to the great loss and dismay of her refiners.

In 1825 France produced a total of 5000 tons of beet sugar, in over one hundred factories.

In 1837 the product was 49,000 tons. A tax of one and one-fourth cents per pound caused the failure of 166 establishments, and the production fell to 22,000 tons in 1840.

This tax was the result of the efforts of the cane sugar manufacturers of the French colonies; the history of this industry from this time is but the record of a struggle with the cane sugar interest, which sought to crush its youthful competitor; but notwithstanding this, the production of beet sugar in France has doubled every ten years and the import of cane sugar declined. Meanwhile the consumption of sugar was rapidly increasing; in 1830 it was but 2 lbs. per capita; in 1865 over 14 lbs. per capita. Since 1865, except in the immediate vicinity of the seaboard cities of France, no sugar is used but the beet. The same is true of Germany. Not an ounce of any other is used in Paris, Vienna, Berlin, Dresden, Leipsic, or Munich.

In 1837 the yield of beets per acre was 12 tons, price $3.00; in 1865 the yield was 16 tons per acre, price $3.25. The percentage of sugar contained in the beets in 1837 was 10 per cent.; in 1865 it was 11 1-2 per cent.

The quantity extracted in 1837 was 4 1-5 per cent., and in 1865, 7 per cent. The cost of sugar per lb. in 1837 was 7 3-10 cents; in 1865 it was but 4 cents. The total product of France for 1837 was 49,000 tons, reduced by unwise taxation to 22,000 in 1840, has increased to 270,000 tons in 1865.

From 1860 the protective duties were removed from foreign sugar without detriment to this industry, and the cane sugar of the French colonies had the advantage of 1-2 cent per pound.

Thus it required nearly half a century to establish this great and important industry, on the continent of Europe, on such a basis as to defy competition. It has been the result of careful and continued attention to increase the percentage of sugar in the beet, by studying the laws of its nature, and then, by the skillful application of chemical knowledge and mechanical ingenuity, to extract it therefrom purified and ready for the most fastidious taste. In addition to constantly diminishing price, with steadily decreasing protection, wages have doubled, and it has been to increased skill alone it owes its present existence.

This sketch, while mainly of France, applies also to the rest of the continent. France only led in the race.

Such is a brief history of the origin and growth of this industry up to 1865. Since then its continued increase is shown by the following statistics:

Total product of beet sugar in 1853,	200,000 tons.
" " " " " 1863,	452,000 "
" " " " " 1873,	1,143,000 "

It may now be considered as one of the established industries of the Temperate Zone, and merely waits the judicious organization of capital and labor to establish it on any suitable soil and locality.

The sugar now extracted is over 8 per cent.

ITS EFFECTS ON AGRICULTURE IN FRANCE.

The effects produced upon agriculture in France by the cultivation of beets for sugar have been astounding.

In the cane sugar districts no other crop is to be seen, while the cattle and sheep are few. The beet sugar districts of Europe, on the contrary, are covered with the greatest diversity of crops; beets, wheat, rye, oats, barley, &c., and all the cultivated grasses every field cultivated, and the stables filled with cattle, sheep, and horses. No farmer need to be told which system is the most enduring. On a great public occasion the following significant inscription was placed on a triumphal arch. "Before the manufacture of beet sugar, the arrondissement of Valenciennes produced 695,750 bushels of wheat and fattened 700 oxen. Since the manufacture of beet sugar was introduced, the arrondissement of Valenciennes produces 1,157,750 bushels of wheat and fattens 11,500 oxen."

The farmers who obtain first prizes at the agricultural exhibitions are so uniformly those engaged in this industry that they would be surprised if they did not secure them. A farm of 832 acres, the sales of produce from which, with the ordinary farming, amounted to $8000 per annum with six years treatment of the sugar beet culture produced $41,200 per annum. Another instance: A farm of 295 acres produced 5225 bushels of wheat, 2500 tons of beets, and fattened 150 head of cattle per annum. But the model farm of France is one of 552 acres, which has been 11 years under sugar beet cultivation, and averages 70 bushels of oats per acre on 30 acres, 36 1-2 bushels of wheat on 150 acres, 20 tons of beets per acre, 3 tons of hay per acre, fattens 800 cattle and 3000 sheep per annum. In 1865 the yield of beets was from 30 to 40 tons per acre. These farmers attribute their success as cultivators entirely to the immense amount of barn-yard manure which the beet pulp, fed to the stock, enables them to make; to the improved condition of the soil, deep cultivation, and also to the increased amount of profitable service of the land consequent upon beet culture, no fallows being required. Before the introduction of the sugar industry into France, farm hands, by reason of a lack of employment, in the winter, were so continually emigrating to the city, that government instituted inquiries to ascertain the cause, and also the best method of preventing it. Now the tendency of workmen to seek the capital is not noticed in the sugar districts, that industry giving ample and well paid employment in the winter as well as the summer months. Wherever the beet is cultivated land advances in value and

wages take the same direction. The wheat is better in quality, the heads larger and heavier, weighing from two to three pounds per bushel above the standard.

The departments in which the beet is cultivated are not grazing districts, in which cattle are raised; but are pre-eminently distinguished for fattening cattle, and producing grain. Cows fed upon the leaves and pulp produce more and better-flavored milk and butter; so that the production of sugar from the beet adds to the supply of bread and meat, and these three leading necessities of man's existence stimulate and aid each other.

THE VARIETIES OF THE SUGAR BEET—SOIL, PLANTING, CULTIVATING, HARVESTING, AND STORING THE CROP.

The varieties of the sugar beet most extensively used are the "White Sugar, or Silesian," the "Imperial," and "Quidlinburger." They penetrate the soil from eight to twelve inches; their greatest diameter is from three to six inches; the weight most desired is from one and one-half to four pounds. This latter is regulated to some extent by a knowledge of the soil, the proper use of manures, and the distance from plant to plant. Large beets are very poor in sugar. If the soil is cultivated a sufficient depth the beet root will grow entirely beneath the surface, but where the ordinary cultivation is used, being unable to attain its length below the surface, it will extend above, where exposure to the sun injures it. Soil suitable for wheat, which has been under cultivation, the longer the better, that admits of deep tillage, clear of stones, clayey but not too stiff, is suited to the beet; also land that is light, rich, and sandy, produces beets dense, easy of preservation, and rich in sugar.

The usual mode of preparation is a good coat of barn-yard manure, plowed in during the fall, at the same time the ground is subsoiled; this loosens it to the depth of twelve or sixteen inches; in the spring one or two light plowings, five or six inches deep, the last time just before planting; it is harrowed smoothly, marked out twenty to twenty-four inches apart, and the seed drilled from eight to twelve inches apart in the row, and one and one half to two inches deep. The seed is soaked about 24 hours in water, and rolled in plaster; sometimes other compounds are used—bone charcoal dust is one—in place of the plaster, or mixed with it.

The principal object of the last plowing and soaking of the seed is to give the beets a good start before the weeds, so as to save labor in extirpating them.

As soon as the beets are grown sufficiently, the cultivator is used, being worked about as we do corn.

The beets are weeded or thinned out to one plant to every 8 to 12 inches, and where vacancies occur they are filled by transplanting when the beets are from 1-2 to 3-4 of an inch in diameter; four or five workings, one or two weedings, and one or two hoeings, according to the season and requirements of the crop, completes the work until they are ready for harvesting, the time for which is in September or October, and is known usually by the under leaves becoming flabby and turning yellow. The harvesting is done by using a mould-board or gridiron plow to raise them; they are then topped placed in piles and covered, usually with the tops, to protect them from the sun. In two or three days they are in condition for storing which is done in long pits or silos. These are made of any convenient depth and width, having reference to earth, for covering, drainage, ventilation, and location near the factory. The chief object is to protect the beet from frost, and keep them in the dark, also to be dry. These conditions secured, they will lose but little of their sugar until toward spring.

MANUFACTURING THE SUGAR—CAPACITIES OF THE FACTORIES—CAPITAL REQUIRED—COST OF LABOR—FOOD FOR CATTLE.

The season for manufacturing commences as soon as the beets are ripe, usually in September, and continues night and day until March, if the beets are to be had. This one advantage of time is of sufficient importance to note that in comparing it with cane, it is about three times longer; therefore the capital required for the beet is only about one-third as much, to do the same amount of business. The manufacturing processes are too intricate and would require more space than the limits of a small pamphlet to describe them. The important materials are cheap fuel, lime, and good water; carbonic acid gas and bone black are also used in purifying. The size of the factories varies from the smallest, producing one ton of sugar per day, to the largest, forty to fifty tons per day; the average being in Russia one ton, and in other parts of the continent six tons of sugar per day of 24 hours.

The capital required for buildings and machinery of the six ton size is about $40,000; for the one ton size, about $10,000. The number of hands required for the former is from 35 to 45 to each turn, and for the latter 7 to 10 according to the machinery used. The coal consumed is about two tons to one ton of sugar. The bone black is almost as expensive as the fuel; the other materials cost but little.

For every ton of sugar about 12 tons of beets are required, which leaves nearly 2 1-2 tons of pulp. This is fed to cattle at the rate of about 80 pounds per head per day, consequently a six ton factory would make 15 tons of pulp daily, sufficient for nearly 300 head; the smaller ones would make 2 1-2 tons of pulp, which would feed 50 head.

It requires 600 acres to produce beets for the six ton factories, and 100 acres for the smaller ones. The pulp can be kept good for many months by storing it in places prepared for the purpose. Some of the factories and the land contiguous are owned by the same parties, but in many cases the factory depends largely upon the neighboring farmers, with whom contracts are made for a certain number of tons or acres of beets, and also for the sale of the pulp in exchange.

In some localities the factory is a stock company and owned by the farmers. The cost of labor in the factories is about one half a cent per pound of sugar.

[*To be continued.*]

[Copyright applied for.]

THE SLIDE VALVE AND ITS MOTION.

By HUGO BILGRAM.

The most successful method of studying and analyzing the action of the slide valve, in its various modes of application, is that which is based on the use of graphical diagrams, among which the one discovered by Zeuner,* is pretty generally considered the best.

This diagram shows at a glance what, by the aid of working models, can be seen only by carefully watching the movement of the slide valve in relation to that of the piston; it shows how an alteration of any of the essential members of the valve gear affects the working of the valve; it is admirably adapted to draw a comparison between different valve gears and link motions on their intrinsical as well as their relative merits; it also furnishes the means, by a reversed application, of finding the proper proportions of valves and the valve-moving devices when a given effect is desired, and how any valve gear can be proportioned to the best advantage. In short, it meets all the principal requirements of the case. Only one feature is in some respects adverse to a general use of this graphical method; in some instances its application requires algebraical calculations, or else an intricate geometrical procedure, and for this reason it can be used only by those engineers who have enjoyed a theoretical education.

In his efforts to fully open this field to every intelligent mechanic, the author found that a modification of the Zeuner Diagram renders the subject in all its bearings purely graphical, and no knowledge of mathematics beyond the most elementary propositions of geometry is required to understand the demonstrations as well as the applications of this new diagram. Nor is this the only advantage gained over the original form; for by this modification the diagram profited in several other respects, especially in regard to clearness, and will therefore give better satisfaction, even to engineers familiar with mathematics.

The following discussions will be held as concisely as is consistent with a thorough and fundamental treatment; and the leading propositions will be amply illustrated.

PROPER DISTRIBUTION OF STEAM.

The steam engine is a mechanical contrivance for converting the power, developed by the evaporation of water, into such a form that it can be utilized for driving machinery or for other industrial purposes. After its generation in the boiler, the steam is caused to exert its pressure alternately upon both sides of the piston, imparting a reciprocating motion, which is converted into a rotary one by a connecting-rod and crank. The valves admitting the steam alternately to both ends of the cylinder, and opening an exit for the steam after the performance of its duty, are name "distribution-valves" and the mechanism operating them is termed "valve-gear."

We shall now consider how the admission of steam should be regulated in order that the greatest amount of useful effect will be realized; this will enable us to judge how near the valve-gears to be considered hereafter approximate to perfection.

I. *Expansion.* To the engineer, the most valuable property of steam is its elasticity, which can most effectively be utilized by admitting steam to the cylinder for a portion of the stroke only. The production of work per stroke will then comprise two stages: (1) The direct action of steam, for the time of admission, when the steam exerts its initial pressure upon the piston, and (2) The action of the expanding steam; in which period the pressure is gradually diminishing.

For economy of steam it is most advantageous to expand until the terminal pressure upon the piston equals the average fractional resistance of the engine. In practice, however, the expansion is not always carried thus far, as an engine accomplishing this result generally demands a higher price than one with a single slide-valve, and purchasers of engines frequently prefer to save in the first cost.

When the load on the engine is subject to variation, the admission of steam must be regulated accordingly. The effective steam pressure upon the piston is usually more or less reduced by throttling the admitted steam by a valve that is operated by the governor. A more economical plan, however, is to vary the degree of expansion by cutting the steam-off at an earlier or later stage of the stroke, if the valve-gear admits of such a variation.

II. *Compression.* That end of the cylinder towards which the piston is moving must be in communication with the exhaust passage. In condensing engines the exhaust passage is in communication with the condenser, where a partial vacuum is produced by the condensation of the exhaust steam. Other engines exhaust into the air, and have therefore a back pressure equal to, or slightly above, that of the atmosphere.

It is of advantage to interrupt the exhaust a short time before the termination of the stroke, and to compress the thus insulated exhaust steam by the piston. At the first glance this statement may appear absurd; but it is nevertheless consistent with both theory and practical experience, for the following reasons:

The "clearance,"—which is the space left at the end of the stroke, between the piston and the end of the cylinder, together with the space of the steam passage between the valve and the cylinder,—is alternately brought in communication with the steam chest and with the exhaust passage, and is thus filled with steam and emptied again. The direct action of this steam is evidently lost, and only part of the expansive power of the same is made available. This continual loss of power can, however, be moderated by compressing into the clearance part of the exhaust steam, raising its pressure to that in the boiler. When thereafter the valve opens the port for admission, no steam is required to fill the clearance, and the full power of all the admitted steam will be turned into useful work. If now the steam is cut off so early in the stroke that the terminal pressure will be equal to that in the exhaust passage, the re-expansion of the previously compressed steam will augment the production of work just so much as to restore the work expended in compression. This shows that under the said conditions the clearance will cause no loss of steam. It must, however, be remembered that in the first place we took no account of friction. The space through which the piston travels during compression, is entirely lost for the production of work; therefore it is evident that an engine with much clearance and corresponding compression, though theoretically equal to one with but little clearance and compression, is practically inferior, for since the travel of the piston must be greater it will involve greater loss from friction. In the second place, we assumed the expansion carried to a degree higher than that generally used. It is, therefore, advisable to compress to a less degree, especially if not much expansion is used; for the work expended for compression will be but partially restored by the following re-expansion.

A second reason for prematurely closing the exhaust is due to the reaction of the compressed exhaust steam upon the piston,—commonly called "cushioning,"—which assists in the reversal of the motion of the piston and other reciprocating parts of the engine and lessens the wear in bearings, and also the thumping caused by lost motion which is usually present to some extent.

III. *Lead.* Experience has taught that both the admission and the exhaust of steam should be commenced a short time before the crank passes the centre. Either port will thereby be opened to some extent at the beginning of the stroke. The width of the opening at that time is termed "lead," while the angle through which the crank passes from the moment of the opening of the port until it reaches the centre is the "lead angle."

One reason is obvious. The steam does not fill the clearance, nor does the exhaust steam reduce its pressure to that of the exhaust passage, the very instant the port for either admission or exhaust is opened; hence the advantage of a premature opening on either side.

As a general rule the lead on the exhaust side is greater than that on the steam side, as the former has the function of releasing the pressure of a volume of steam filling the entire cylinder, while the latter need only fill the clearance with live steam. The opening of the *exhaust* is mostly effected while the piston is still an appreciable distance from the end of its stroke, and is more commonly called "release," while the *admission* mostly begins when the piston has practically arrived at the end of its travel.

The most advantageous amount of lead on the exhaust side depends mainly on the terminal pressure of the expanded steam; and should, therefore, be greater on engines with late cut-off. High speed engines need more lead on both sides than slow running ones, to allow the proper time for the functions of lead. Excessive lead on either side always results in waste of power.

There is another very important motive for lead on the steam-side. The cushioning of the piston by compression does not always suffice to neutralize the effects of the momentum of piston and connecting-rod. Lead affords an easy means of supplementing the cushioning, and it may be adjusted until the thumping of the engine ceases.

High speed and beam engines need more lead than others, because of the greater momentum to be overcome.

(*To be continued.*)

**Schiebersteuerungen*, by Prof. Dr. Gustav Zeuner.

PROGRESS IN SCIENCE AND THE ARTS.

[☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*]

ENGINEERING—CIVIL, MECHANICAL &c.

Increase of the Limit of Elasticity of Metals by Prolonged Tension.—Uchatius has determined that such metals as are used for the manufacture of ordnance can have their limit of elasticity increased by prolonged tension beyond their first limit of elasticity. On the application of the first weight, the metals become permanently extended, but after this will bear often as much as 3 to 4 times the burden without any additional extension.—*Dingl. Journal, per Berg u. Huetten. Ztg.*, xxxvi, 207.

An Ingenious Invention for Economizing Fuel, successful in London, is about to be tried on the Grand Trunk road. It consists in making the sides and bottom of the furnaces of engines of tubular plates, through which the water flows from and into the boiler. The saving of heating power is plain, and in practice it is found to be about thirty per cent. of the fuel consumed.—*Engineering News*, iv, 168.

The Interior Sea in Algeria.—The proposal to let in the sea to the Algerian Sahara is being freely discussed in the French Academy, some of the members of which do not see anything but advantage in it. The case of Egypt has been cited, in support of the project, and the improvement of its climate since the Suez Canal was opened and plantations increased; but, it is replied, the Algerian shotts are very differently situated with regard to the sea, and have no Nile to refresh them and procure them the fresh water indispensable to cultivation; and the production of new rivers seems doubtful. M. Naudin thinks the interior sea would very likely turn out to be an immense pestilential focus, made by human hands at a great cost. The maximum depth is estimated at not more than 24 to 25 metres; but a more important question is, What of the borders of the lake? There would necessarily be a long stretch of shallows, which would be left dry in the hot season, and would present all the conditions of insalubrity—mixture of salt and fresh water, bright solar light and tropical heat during two-thirds of the year. This would generate a vast number of vegetable and animal organisms, which, falling into putrefaction, would corrupt the air for leagues around. The only feasible way M. Naudin sees for converting the bad Saharan region is the plantation and sowing of arborescent vegetation which might suit the soil and climate. If the Australian Eucalyptus could grow in a soil so impregnated with salts, good and well; if not, the Tamarix might suffice to prepare the soil for a more important vegetation to follow. But it is specially desirable to re-cover the slopes and summits of the Algerian mountains with Larices and Aleppo pines, and oaks and chestnuts, with a view to modifying the climate.—*English Mech.*, xxv, 382.

A Car Heater.—Mr. Mason, secretary of the St. George's Hall Company, has recently patented an invention in which he claims to regulate the temperature of railway carriages in winter to a more uniform degree of heat, and consequently to give more comfort to the passengers by utilising the exhaust or waste steam from the locomotive engine, to dispense with the foot-warmers now in ordinary use, and save the expense now incurred by railway companies in heating the water and labor in filling the foot-warmers with hot water. He accomplishes this in the following manner:—With suitable connections to the blast pipe of the locomotive engine, the exhaust or waste steam is conveyed through the carriages in pipes arranged under the seats, or otherwise, as may be found most advantageous, the outlet of the pipes to be at the rear of the train. The amount of steam passing through the pipes which gives the requisite temperature is under the control of the guard of the train, and the pipes in the various carriages are attached together by means of flexible tubes, in order to allow for the varying distances between the same when starting or stopping the engine.—*Iron*, ix, 778.

Progress of the St. Gothard Tunnel.—The advancement made on the St. Gothard Tunnel during the week before last was 30.3 m. at the Goeschenen and 17 m. at the Airolo end. A progress of 6.75 m. per day.—*Moniteur Indust. Belge*, iv, 290.

New Anthracite Coal Breakers & Dust Remover.—The Philadelphia and Reading Coal and Iron Company is about to adopt two contrivances for anthracite coal breakers, which will materially lessen the cost of preparing the coal, when put into operation. The first is the erection of steam "tips" for dumping the coal from the mine-wagons into the receiving chute. In the present method great manual labor is required, and much waste is produced by the violence with which the coal is emptied. The principal saving by the use of this apparatus will be: 1. Decrease of breakage of the coal. 2. Decrease in muscular exertion required of the men, and consequently a cutting down of the number employed, or the substitution of boys for men.

The second improvement consists in the removal of the dust or dirt from the breaker to the culm bank by means of buckets on an endless band. This method will be continuous and self-dumping, ordinarily calling for no additional motive power, and doing away with all men, mules, wagons, and tracks now used on the banks. The band will admit of being carried to any height or depth in any direction, and also of being lengthened or shortened at any time.

MINING, METALLURGY AND MINERALOGY

Minerals containing Columbium from New Localities in the United States.—Mr. J. L. Smith, of Louisville, has examined several species of minerals containing columbium, and claims the restoration of this name for the metal instead of that of niobium, generally given to it in England and on the Continent. His reason for making this reclamation is that the name niobic acid was incorrectly given by H. Rose to one of the acids found by him in his researches on the columbite of Bodemais, and subsequently proved by him to be identical with the columbic acid originally discovered by Hatchett in 1801. The name niobic acid, however, given by Rose, has never been altered, and Mr. Smith thinks the original columbic acid should have been retained. In remarks on the chemical constitution of the minerals described by him, Mr. Smith thinks that the composition of the columbates, although appearing at first sight complex and irregular, becomes much simpler when due allowance is made for the intermixture of the different varieties with each other. Columbite, the best known of the minerals, can be well recognised as a simple columbate of iron and manganese; microlite appears to be a columbate of lime; pyrochlore, a columbate of the cerium oxides and lime, but whether or not a neutral columbate remains to be investigated. Hatchetolite he considers as a neutral columbate of uranium and lime, and samarskite a basic columbate of iron, uranium and yttrium oxides. Yttrotantalite and euxenite are basic columbates of yttrium and uranium, the first being anhydrous when pure, the second containing water. Fergusonite is a hydrated basic columbate of yttria, and rogersite a columbate still more basic. In arranging a general view of these minerals, Mr. Smith does not take into account the constituents which exist in small quantities only.—*Nature* xvi, 167.

Recent Improvements in Steel Process.—A knowledge as to what are the chemical ingredients of steel, what is needed to give certain characteristics to metal to prepare it for certain uses, and where these ingredients can be found and in what proportionate quantities, is now the question necessary to supplement the action of the Bessemer converter. It is already nearly known what the Bessemer process leaves in the converter after the carbon is burned out, and it is only necessary to know what there is in a piece of plow steel, tool steel or cutlery steel not in the Bessemer converter, and how to obtain those ingredients either by themselves or in connection with other ores and introduce them into the converter as spiegelisen is now put in to obtain direct from the converter an ingot of any desired character and quality. But will this be done? English metallurgists are experimenting, with some degree of success, in this direction, and have succeeded in producing a cheap, low quality of steel which they are making into tools and cutlery of a poor character. This is about the condition of the discoveries abroad, and of what has been accomplished through the use of chromium and the addition of more carbon.

In America a quality of steel suited to almost all uses excepting fine tools and cutlery is now made from the Bessemer converter or by re-welding the old scrap. In several instances the scrap is utilized for horse shoes, notably at Troy, N. Y., Pittsburgh and Cleveland. Cleveland is also making steel screws and tacks, and the St. Louis Bolt and Iron Co. is producing tires, harrow teeth, etc., from re-welding Bessemer scrap, old rails, etc, by a patent process of their own. The Harrison Wire Company has utilized a great quantity of scrap Bessemer by re-rolling by another process, which operates as a flux, and then drawing into steel wire. Bessemer, when faggoted and heated to a high heat in a closed furnace, is welded and re-rolled with about the same ease as iron.

Other uses of Bessemer steel, one by the Laclede Rolling Mills is reported to us, wherein a flux was used and old rails re-rolled successfully for street and other purposes. Now that old Bessemer rails are abundant, at $25 to $30 a ton, this industry bids fair to be a successful one, and we believe all the rolling mills in this vicinity have made successful experiments in this direction, and other iron works are considering the subject with a view to increase and diversify the iron interest.

From re-melted Bessemer scrap we have been shown a specimen of tool steel and of cutlery steel made by the addition of a flux in the crucible, which specimens, tempered at a lower heat than ordinary steel, indicating the presence of too much carbon, showed a successful result. So far for scrap Bessemer. Other experiments are in progress, which we shall note from time to time.—*The Age of Steel*, i, 12.

Mechanical Puddling Compared with Hand Labor.—Mr. I. Lowthian Bell expresses himself confidently on the distinct superiority in freedom from phosphorus which marks iron made by mechanical puddling over that obtained by hand labor.

Refractory Materials.—Prof. T. Egleston.—These materials are usually clays, which are silicates of alumina, and a few natural rocks. Rocks can rarely be used, as they are never homogeneous, and are liable to crack; clays cannot be used as they are found, but must be mixed with other substances. They are refractory in proportion to the alumina they contain, and less useful, as they are acid; two or three per cent. of iron is sufficient to make a brick fusible at high temperature. Silica alone is exceedingly infusible, but has no binding power. The Dinas brick, which is silica, is formed by one and a half per cent. of lime, and will resist a clear white heat alone, but is worthless if it comes in contact with metallic oxides; two per cent. of oxide of iron would make such a brick useless in a Siemens-Martin furnace. A silica brick expands to such an extent that the rods of a furnace have to be loosened while it is being heated, and tightened when the furnace cools. Alumina is also very infusible, but it contracts at a high heat, and has therefore to be mixed with silica or burned clay, to prevent this contraction, as any depressions or contractions would make eddies in the flame and rapidly destroy the furnace. Bauxite, a hydrated compound of alumina and iron, which sometimes contains a little silica, and sometimes none at all, is also used. Siemens makes a brick of this substance, which contains three to five per cent. of silica only, which is five times as infusible as the best Stourbridge brick. We have the anomaly of six per cent. of oxide of iron making one material as fusible as ordinary brick, and another, containing over 20 per cent. of the same material, being infusible. Lime and magnesia are also very refractory; they are both used to make crucibles for the fusion of platinum, but lime can only be had as a carbonate, which, under heat, becomes caustic, and when the heat is allowed to go down it slacks and falls to powder, so that it can only be used as in Styria, in very small continuous furnaces As lime is never friable, the campaigns are never long. Magnesia is also a very refractory material, but difficult to get. Beside the effect which the chemical composition has upon the refractoriness of materials, there is an effect due to molecular condition which has been but little studied and is still less understood.

What is demanded to-day by our present metallurgical practice is a better material than we now have. Mr. Holley has shown that the cost of refractory materials for a ton of Bessemer ingots is $1. For the Siemens-Martin process this expense is $5, while in Wales it is only $1. This shows the necessity of a careful discussion of the whole subject, which should theoretically be fusible, and then submitting them to the temperatures they should sustain, and then making a careful chemical analysis, and also a mechanical and microscopical examination.

Mr. A. L. Holley, at a subsequent meeting of the Institute, in connection with this subject, presented the drawings of the details of a Pernot furnace, where it is necessary to hold up the roof, which is very drooping. This is proposed to be accomplished by the use of a lathing of water pipes; that is, letting the pipes hold up the fire-brick roof, instead of the brick supporting itself. The roof is intended to be monolithic.—*Mines, Metals and Arts*, vi, 83.

The Role of Manganese in Metallurgy.—Under the influence of elevated temperatures, manganese forms combinations with other elements, and in the formation of such combinations evolves greater heat than iron does in analogous compounds: further, these manganese compounds easily oxidize and form fusible slags with the evolution of great heat.—*Comptes Rendus, per Berg u. Huetten. Ztg.*, xxxvi, 208.

—Among the curiosities taken from a Nevada mine is a piece of sandstone with grass roots still clinging to it, and showing native silver all over its surface, petrified wood impregnated with ruby silver, and a mass of pure chloride of silver that will assay at $8,000 a ton.

Phosphor-Bronze.—MM. de Ruoiz Montchal and de Fontenay (*Comptes Rendus*) have since 1854 been experimenting very extensively with phosphorus for the production of metallic alloys. They have succeeded in forming a phosphor-copper which contains 9 per cent. of phosphorus. It is of a steel gray color, is brittle, capable of a high polish, very sonorous, and can be maintained in a fused condition for many hours without losing its contained phosphorus. The phosphor-bronze, which contains 0.3 per cent. of phosphorus, is harder and consequently withstands wear better than the ordinary bronze.—*Technische Fortschritte,* xi, 25.

Discovery of Extensive Nitrate Deposits in Chili.—The report of the engineer—Senor Vadilla—who was sent to survey and measure off the claims applied for at the place called Cachinal de la Sierra, has been forwarded to the Minister of the Interior, and published in the Government *Gazette,* and gives a fuller account of the discoveries than has hitherto been made known. The deposits in question are three in number, situated to the south of the 25th parallel; the first at a distance of about 16 miles to the southeast of the port of Paposo; and the second and third in an extensive plane, calculated at 18 miles in length by 18 or 20 in width, running from east to west, and distant from the same port about 55 miles, in a southeastern direction. Senor Vadilla examined all the land in which prospecting had taken place, a large number of holes having been put down at different distances, in all of which beds of nitrate were discovered. Under the sandy surface a stratum is found which is in parts sulphate of soda of tolerable purity, and in others a mass composed of sulphates and of caliche, mixed with the surface sand. Under this is situated the bed of nitrate, which is from 40 to 60 inches in thickness. The deposits are considered to be of great extent, being met with in all the holes sunk, and also wherever the earth was removed to the depth of 20 inches by the inspecting engineer. The first deposit measured gave a superficial area of 300 acres; the second, 920 acres; and the third, 2,717 acres; or a total of about 5,000 acres. To obtain a fair approximation as to the quality of caliche, samples were taken from various localities, mixed together, and analyzed, the result being as follows:

Common result of the first deposit—lye.....51·5 per cent.
" " second " .....29·7 "
" " third " .....41·7 "

"These lyes," says Senor Vadilla, "show the pure anhydrous nitrate of soda contained in the caliche, and obtained not from isolated samples but from a number taken on the field itself, and with all the care possible in such a locality. I have not assayed separately any of the samples which composed the collective one, and some of which I believe would give a lye of even 80 per cent. because I consider that what is necessary to be known is if, throughout the great extent of land comprising the nitrate deposits of Cachinal de la Sierra, the average quality is such that it may constitute a new industry for the country. Considering the result of the analysis, I regard it as satisfactory, and have no doubt whatever that the same samples assayed on the spot would show a higher lye; for when I arrived at Copiapo they contained a larger quantity of water than they did at the deposits, which would naturally diminish the lye of the nitrate, which is nitrate of soda, containing scarcely traces of potash. There can be no doubt entertained whatever over the existence of nitrate deposits in Chili, and nitrate of good quality." With respect to the facilities of exportation, Senor Vadilla recommends the use of the Port of Taltal in preference to that of Paposo, not only because of the difficulty of constructing a road to the latter place, but also because of the insecurity of the bay. According to his calculations the deposits are situated at only eight or ten leagues from the road leading from Cachiyuyal to Taltal, to which a cartway might be easily made, the country being level and the distance short—Taltal being, besides, a well sheltered bay, and with facilities for loading and discharging.—*Sci. Am.* xxxvii, 8.

New Alloy.—A very beautiful new alloy, intended to replace brass in various ornamental uses, especially in window and door furniture, has been invented by Mr. W. A. Hopkins, of Paris. The alloy is composed of copper, tin, spelter or zinc and lead, which metals are manipulated. A crucible is placed in the furnace and fired to a red heat, and into the crucible thus heated the metals are placed in the proportions of—tin $1\frac{1}{8}$ (say) 1 oz., spelter or zinc $\frac{1}{2}$ oz., lead 5-16ths of an ounce. These are the proportions he prefers to use, as he has found them to give excellent and satisfactory results, but he does not intend to confine himself rigidly to the precise proportions named, as they may, perhaps, be slightly varied in some particulars without materially detracting from the beautiful color of the alloy which it is intended to produce. The molten metals are kept well stirred, and any impurities therein should be removed. When thoroughly mixed this alloy, which is termed the first alloy, is poured off into ingot molds and left to cool. Copper in the proportion of eight parts to one of this first alloy is then placed in the crucible and brought to melting heat, when the tin or first alloy is added and intimately mixed with the copper, for which purpose the molten mass must be well stirred for several minutes. It is then poured into ingot molds for sale in the form of ingots, or it may be poured into pattern molds so as to produce the articles required. This is the mode of manipulation which it is preferred to employ, as an opportunity is thus afforded of removing any impurities from the first alloy before mixing it with the copper, but all the metals may, if preferred, be mixed together in the proportions given and melted at one operation. By this means an alloy is obtained of great strength and of a very beautiful appearance, and which is particularly suitable for small work, such, for instance, as window and door furniture and other house furniture which is usually made in brass or other alloy of copper, though it is not intended to confine its use to such articles.—*Iron Age.*

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Danger to Health from Aniline Coloring Matters has lately been investigated by M. Seidler, of Riga (*Deutsche Ind. Zeit.*) He considers that pure aniline dyes have no injurious action on the outer skin. This appears from experience of workmen who handle them. They have the property, too, of adhering very firmly to the cloth fibre, without a mordant, and do not come away in dust through mechanical action. An extensive experience of articles of dress colored with aniline dyes has not revealed any injurious action. But the case is different with stuffs printed with aniline colors. Here the coloring matter is used in a more or less concentrated state, and it may be easily rubbed off, and enter the mouth and stomach. The chemically pure dye would, of course, not be dangerous. But if it contains considerable quantities of arsenic or poisonous acids (prussic or oxalic), or if the dye has been fixed with a poisonous mordant, a poisoning of the skin or of the whole body may occur. Paper-hangings, painted with aniline colors, may be very poisonous, for a number of careless manufacturers purchase the aniline dye residue, which often contain a large amount of arsenic.—*English Mech.*, xxv, 382.

Engraving with Electricity —The applications of electricity seem to be unlimited. We are informed that an ingenious inventor has succeeded, after many tedious trials, in constructing a machine for engraving by means of electricity. The design is placed under one, and the plate to be engraved under the other pole of the battery, the latter being supplied with the engraving tool. When the battery is set in action, an ivory button moves horizontally over the design and, since the latter is made a conductor, thereby closes the circuit and affects the metal under the other pole, producing a fac-simile on the plate. If it be desired to produce a relief plate, it is only necessary to reverse the poles of the battery, and the functions performed on the design and plate will be reversed likewise.—*Papier Ztg.*, ii, 384.

Detection of the Artificial Coloring of Brandy.—It is a well known fact that the longer brandy is permitted to remain in the cask the darker it gets in color,—due to the taking up of the coloring matter in the wood. Liquor dealers have a strong inclination to have nothing but old brandy, so-called, in stock, therefore color their young liquor by means of burnt sugar (caramel). This falsification is at once apparent to the practised tippler, but a chemical test is nevertheless very desirable. Herr E. Carles discovered that the falsification referred to can be detected by means either of the albumen of an egg or sulphate of iron. If to two samples of brandy, the one colored by natural means, the other by sugar, $\frac{1}{6}$ of their volume of albumen be added, they will become turbid. On clearing, either by being permitted to stand quietly or by filtration, the artificially colored liquor will retain its color while the unadulterated will be almost colorless. The addition of a concentrated solution of sulphate of iron will not affect the tampered liquor, while the true article will be colored to a blackish green color, more intense as the brandy is aged.—*Fresenius' Zeitschrift,* 1877, 128.

The Preparation of Sulphuret of Iron.—The sulphide of iron which is used in the chemical laboratory for the preparation of sulphuretted hydrogen gas, is obtained by smelting together sulphur and iron; but although these materials are very cheap, yet the product, the sulphide, is, comparatively speaking, quite expensive. In consideration of this fact, Herr C. Méhu recommends the use of iron pyrites (a disulphide of iron) instead of the sulphur. The recipe is as follows: If 2 parts of finely ground pyrites and 1 part of iron filings be placed in a Hessian crucible and submitted for a $\frac{1}{2}$ hour to a red heat, a mass is obtained which is easily reduced to powder, and which gives off sulphuretted hydrogen gas in great volume when treated with hydrochloric acid. The formation of the single from the disulphide is caused by the following reaction:

$$FeS_2 + Fe = 2FeS.$$

It is not at all necessary that the mass in the crucible be brought to a smelting heat, since the reaction takes place even at a red heat; it is however necessary that the materials be in a powdered condition and be intimately mixed in the crucible. The material should not be too closely packed.—*Fresenius' Zeitschrift,* xvi, 229.

The Rapidity of Chemical Action.—Herr S. Bogusky has published in the *Ber. d. Deutsch. Chem. Gesellsch. Z. Berlin* the results of a series of experiments which he made with Carrara marble and hydrochloric acid of different degrees of concentration; these results appear to show that rapidity with which carbonic acid is evolved (under similar condition) is proportionate to the concentration of the acid.—*Fresenius' Zeitschrift,* xvi, 230.

New Reagents for Free Mineral Acids.—Herr Huber, in the *Pharm. Centralhalle,* suggests the use of a solution of molybdate of ammonia and ferrocyanide of potassium for the detection of free mineral acids. If a clear yellow solution of these reagents be added to a colorless solution containing salts of alkaline earths with traces of mineral acids, (sulphuric, hydrochloric, nitric, phosphoric, arsenic, sulphurous, or phosphorous acids) the solution will turn at once to a reddish yellow color, which approaches more or less to a dark brown as the quality of acid present is greater or less; the turbidity which often occurs in the solution at once disappears in the presence of an excess of alkali. Boracic and arsenous acids give no reaction. These reagents suggested are admirably adapted for volumetrical determination.—*Fresenius' Zeitschrift,* xvi, 242.

The Sub-Marine Cables of the World.—According to the report given in the "Electricité," there were 206 cables laid, having a total length of 80,000 kilometers, by the end of 1874. The "Journal-Télégraphique" gives 269 as the number of cables in position in 1876, representing a length of cable equal to 63,989.78 nautical miles. The entire network of sub-marine cables is owned by 21 private organizations and 17 governments. These 21 private companies own 149 cables or a length of line equal to 59,547.55 nautical miles. The most influential of these companies is the so-called Eastern Telegraph Company, which alone represents 39 cables of a total length of 14,502.75 nautical miles. The next largest is the Anglo-American Company, with 17 cables of 12,315.12 miles length. Of the governmental companies, the Indo-European has 6 cables of 1,721 miles length, France has 26 cables having a length of 673 miles, Germany 21 cables with 149.25 miles of line. Of the entire number of cables 45, with 20,895.12 miles length, are worked independently by the St. Petersburgh Telegraph Company; the others are either entirely or in part worked in accordance with specific contracts made.—*D. A. Polytech. Ztg.*, v, 294.

MISCELLANEOUS.

Finer Workmanship.—Coarse work and articles of common, everyday use are necessarily the first productions of a people, and as fast as the workmen improve or advance toward finer work, higher skill, taste and execution, so fast are they making progress in what pertains to profit and success. In many industries in this country the first steps of coarse work are already passed and we have entered upon the fine art productions; but the progress is by no means so rapid, nor is our position as a nation of fine art workers by any means so well established as could be wished. The great proportion of fine art work in porcelain, glass and fancy goods ornamenting our dwellings still comes from Europe. The fine silks are in part produced here, as are some fine cottons and woolens, the finer dress goods come from France still. Our fine linens, velvets and laces all come from abroad.

In machinery and tools the judgment of the world is in our favor for lightness and general character of finish and adaptability. In cutlery the finer goods are of Sheffield make. So far as fine taste is displayed in design and finish, so far articles are saleable in any market, and from this it is easy to see in what the successful competition for the world's markets is to consist.—*The Age of Steel,* July, 1877.

Oleomargarine.—The exportation of oleomargarine or artificial butter from New York, during the period from Sept. 1st, 1876, to March 31st, 1877, amounted to 1,775,815 kilogrammes representing a value of 2,208,735 fr. Of this total, 1,176,125 kilog. were sent to France and 495,665 kilog. to England.—*The Export Jurnal of New York.*

Important Discovery of Potash Salts in Prussia.—A discovery of mineral salt of much interest and importance has, says the *Times,* recently been made at Aschersleben, in Prussia, in the vicinity of the Hartz Mountains. Within the last twenty years the governments of Prussia and Anhalt have been deriving large profits from the working of sundry pits or mines productive of potash salts, situated at Stassfurth and Leopoldshall. Hitherto these undertakings have enjoyed a monopoly, but an independent party of explorers, aided by the diamond rock-boring apparatus, have succeeded in reaching the potash deposits at moderate depths not far from Stassfurth.

The first boring reached what is called the "kainit" portion of the potash layer, which was proved to have a thickness of fifty English feet. As the Prussian mining law entitles the discoverers to a concession equal to an area of 2,189,000 square meters, it is computed that this discovery includes about 66,000,000 tons of potash salts. But the explorers, consisting chiefly of English capitalists, have proceeded further, and by means of other borings have obtained the command of an enormous area of these valuable deposits, which are now going to be extensively worked. The discovery is likely to be of great service to the chemical industry, by providing an ample supply of one of its staple commodities, the want of which threatened at one time to be rather serious. The extraordinary fertility imparted to the soil by the use of potash manure also renders the discovery a matter of direct interest to the agriculturist. Experience gained in Germany and Holland shows that, by the use of the kainit and other forms of potash, land naturally poor can be made to bear extraordinary crops. This system of fertilization has been found peculiarly advantageous in the case of peat lands and moors.

—Baird & Houston, of Philadelphia, have been awarded the contract by the Lighthouse Board for the building of the new iron twin screw tender Pansey. The vessel will be 153½ feet long, 10½ feet depth of hold and 25 feet beam. She will be rigged as a fore and aft schooner, with pole top masts. She will be propelled by an inverted surface condensing engine, 21 inch cylinder and 25 inch stroke, driving one right and one left-handed screw. The boiler is one of the return over-head flue type, 8 feet front, 8 feet 6 inches diameter, 20 feet 6 inches long. Chimney 24 feet high and 42 inches in diameter. She will be finished this fall.

—The pipe works of Spang, Chalfant & Co. are running double time.

—Over one hundred men are at present employed in the Chester Rolling Mills, manufacturing plate iron.

—The Pennsylvania Steel Company, of Harrisburg, have orders sufficient to keep the works running day and night for four months. Twelve hundred hands are employed.

—A saw 54 feet long and 8 inches wide, intended for use on the big trees in California, has just been turned out at the Beaver Falls Steel Works.

—The Oliphant Furnace is out of blast, and will remain cold until the railroad to it is finished.

—The Pratt and Whitney Company, at Hartford, shipped eleven Gardner machine guns to China last week.

—A lead and zinc company, has been organized in Crittenden county, Ky., with a cash capital of $300,000.

—Mr. Willard P. Ward is making two tons daily of 50 per cent. ferro-manganese at his furnace at Cartersville, Ga.

—Two barks were recently launched at Quebec, built to carry kryolite from Ivigtok, South Greenland, to the Pennsylvania Salt Company's Works, at Greenwich Point, Philadelphia. The frames are very solid, and double the size of an ordinary vessel, well fortified for ice, diagonal pointers and five-inch planking. The bows are iron-plated.

—The tinning department at the U. S. Tin Works, McKeesport, started on Friday, after having been idle for three months. The company has large orders ahead. A new office will shortly be erected by the company, which will be located nearer the mill, with wareroom underneath. The building will be finished in good style, with directors' room, paymasters' department, business office and post office department.

—Philip S. Justice of Philadelphia has during the past few years furnished about 250 of his Dead Stroke Power Hammers to the various manufacturing companies and railroad shops of this country, besides a large number of European buyers. He has just completed an order for four hammers for Messrs, Allison & Co., Philadelphia.

—The utilizing of coal dust by mixing with other material and forming into bricks is a new industry at St. Louis.

—The Harrison Wire Company of St. Louis is running to full capacity on steel and iron wire rods, and wire of different kinds, and have a demand for all they can turn out.

—The McGowan Pump Co., Cincinnati, is making Hydraulic Signals for the Lake Shore & Michigan Southern Railroad. Harry Tilden, of that road, is the patentee of the system, which is soon to be applied also to switches.

BIBLIOGRAPHICAL NOTICES

Sanitary Engineering.—A series of lectures given before the School of Military Engineering at Chatham, 1876, by J. Bailey Denton, F. G. S., M. I. C. E., author of "Sanitary Works," "Storage of Water," "Villiage Sanitary Economy," "Progress of Land Drainage in Great Britain," "Farm Homesteads of England," 430 pp., copiously illustrated with cuts and folding plates. 8vo. cloth, $12.00. E. & F. N. Spon, London and New York.

This work is too important to read and review hastily; hence we acknowledge its receipt and postpone other mention until it can be given the extended notice which its importance deserves.

ANSWERS TO CORRESPONDENTS.

WELDING AND CASTING COPPER. (C. C. B., Milwaukee). You can forge copper cold, but not weld it. The art of hardening (except somewhat by rolling and annealing) has been lost. It does not make good casts, as it does not expand at the instant of solidifying as water and iron do. Muntz metal (copper 66, zinc 33, lead 1) can be hot rolled.

STRESS AND STRAIN. (R. T. H., Lynn, Mass.) Stress is a force tending to deform a body. Strain is the deformation.

I BEAMS. (H. H. T., Chester, Pa.) An iron I beam has its upper flange subjected to compression and its lower to extension, and as cast iron has greater crushing than tearing strength, the bottom flange should be the widest and heaviest. Steel and wrought iron having greater tearing than crushing strength, the lower flange might be the lightest. In these last there is a tendency to buckling in the upper or compressed flange.

ELLIPTICAL RIVETS. (C. H. R., Scranton, Pa.) The efficiency of a riveted joint is as the quotient of the diameter of the rivet into the difference between the distance between rivet hole centers and the diameter. Now if we decrease the rivet diameter across the direction of shearing (using the same area of metal) we make the numerator of our fraction greater and the denominator or divisor smaller, and thus increase the ratio in two ways. Hence elliptical rivets are advantageous.

TROUBLE WITH SHAFTING. (C. H. & Co., Toledo.) Your shafts may be strong enough to bear the twisting, that is to transmit the power, but may bend with their own weight or that of pulleys, or the pull of belts thereon. Put your hangers closer together.

WIDE QUARTER TWIST BELTS. (P. & L., Wilmington.) You can get round the trouble by having two or more narrow belts side by side, but connected by cross strips to keep them parallel.

LENGTH OF JOURNALS. (R. H. & Co., Chicago.) The higher the speed the greater the length requisite. For 150 revolutions per minute, 1 diameter is often sufficient; for fan-shafts running at 5000, 6 to 8 diameters are sometimes used.

CRANK PINS. (W. J. S., Canisteo, N. Y.) Remember that you are working with higher pressures and speeds than in the days when your rule was given.

WROUGHT IRON PIVOTS. (G. C. & Bro., Erie, Pa.) These run easier on gun metal than on lignum-vitæ. Cast iron pivots run easier on gun-metal steps than the wrought ones do.

LEAKAGE AROUND BOLT HEADS. (H. & M'C., Cincinnati, Ohio.) Try copper washers to stop it.

STEEL COTTERS. (C. Bros., Baltimore.) It is safe to make them ¾ the breadth of wrought iron ones, having other dimensions the same.

PIPE JOINTS. (J. O., Mendota, Ill.) The flange-joint is the strongest, but for underground the "faucet" or bell joint is best, because adapting itself to inequalities in the line. The latter is the cheaper, but is weaker and harder to connect or disconnect. A modification of the flange is the "lens joint," having one flange face convex, and bearing on a metal packing ring.

DRILL-HOLE IN STAYS. (C. H. T., Philada.) As the tendency of screwed stays is to break across at the screw-thread, inside the plates, a tiny hole, of say ⅛ inch, is drilled in the end to give notice, by leakage, of a fracture.

BOLT TENSION. (W. H. A., Paterson, N. J.) A bolt *has* a slight twisting stress put upon it by an axial or longitudinal force. It is most liable to break at the bottom and end of a thread, because there is the greatest change of section and the predisposition to fracture.

W. K. S., Newburgh, N. Y., writes as follows: "Can you give me a practical and cheap method of ridding cistern-water of an unpleasant odor arising, I think, from locust-blossoms getting in the water? We have tried copperas without effect. A few weeks ago the water was perfectly pure and sweet."

By the addition of a few grains of permanganate of potassa, or of a few handsfull of freshly-burned charcoal. The latter substance has great absorptive power for organic matter. The addition of copperas is not only quite useless, but would render the water utterly unfit for drinking, as it is poisonous. The difficulty with the water, we think, arises from a fungous growth, which would be likely to occur if the water had been kept standing for some time.

TO RENDER SOFT HAIR HARDER. H. W. F., Philadelphia, wants to know how to stiffen soft hair used by upholsterers which has very little value. We can only advise our correspondent to try dipping the material in mineral solutions, and would suggest the preparation of a dilute solution of silicate of soda. After dipping and drying, the hair ought to be somewhat stiffer. It might, however, be rendered too brittle. We would like to hear of the result of the trial.

RECIPE FOR AN ELASTIC TRADE-MARK. The same correspondent wants to know of a substance, not metallic, white in color, and slightly elastic, from which to stamp a thin trade-mark. It paraffin will not do, let H. W. F. try a stiff mixture of white glue and whiting or chalk, dissolving the glue first in clean water in the usual way, and then adding the whiting until the mixture appears to be thick enough.

EDITORIAL CORRESPONDENCE.

Editors of POLYTECHNIC REVIEW:

Sirs—There are three or four statements frequently made by workmen more or less versed in mechanics that I feel called upon to dispute.

First. If you increase the wearing surface, you increase the friction, which, as usually understood, is of course not so.

Second. That there is a great loss of power in the use of the crank in the steam engine; or, that if a good rotary engine could be made to work well, there would be a great gain in power, which is not true.

A third one is the common statement that a belt will run to the highest place on a pulley, which, as the term highest is usually interpreted, is, in five cases out of six, not so.

When a horizontal belt runs too far to the east on a counter-shaft pulley, and a workman is found blocking down the east hanger, on the theory that a belt will run towards the "highest side of a pulley," it makes one think it is about time the promulgation of this theory was stopped.

As you have inadvertently used the same expression in your article on wide belts, in the last number of the REVIEW, I beg to call your attention to the fact. As the expression is likely to be interpreted, it may lead to a result exactly the reverse of the statement. That a belt will run towards the largest part of a pulley, unless it is pretty persistently resisted, is certain; but that it will run towards the highest part of a pulley depends whether the advancing side is running up or down. If running down, it will; if running up, it will not.

If a belt is absolutely straight, and the pulleys exactly of the same diameter at the edges, the belt will run true when the edges of the pulleys are in line; but as belts are not always straight nor pulleys true, it becomes necessary to adjust counter shafts to suit circumstances. If a belt on a counter shaft runs too much to one side on the counter shaft pulley, nothing but moving that end of the counter shaft away from the line shaft is necessary to make it run right. If a belt does not run properly where the two shafts must remain parallel, either the belt is crooked or the pulleys not true, or both. If the belt is crooked, it can usually be neutralized by changing ends with one half of it; when both the belt and the pulleys are wrong, changing ends with the entire belt may overcome the difficulty.

If it is worth while to prevent the water from taking up the air in the steam fire engine pumps, a quart or less of oil introduced into the air-chamber will, I believe, do it effectually. In an experiment I tried with a manometer, where the pressure was from 100 to 190 lbs., a film of oil one-eighth inch thick remained for months between the water and air. Before the introduction of the oil, the air was absorbed at such a rate as to change the indications 10 lbs. per day. If the steam fire engine pumps were arranged so as to have enough water to cover the outlet, it would not be necessary to supply fresh oil every time, as the oil could not escape or be forced out unless blown out by pumping in air.

Very respectfully yours, JOHN E. SWEET.

HIGH OR LOW PRESSURE.

Editors POLYTECHNIC REVIEW:

Permit me to offer the following tables as a supplement to the article on the above subject in No. 23 of the last volume of your paper. They have been calculated from the formula given in that article, which also takes into account the influence of back pressure

CONDENSING ENGINES.
Assumed back-pressure, 3 deg. above zero.

Initial Pressure above Zero.	Rate of Expansion.	Pounds of water per H. P. per hour.	Ratios of Economy.						
30	3	19							1
45	4 5	15.45						1	0 813
60	6	13.17					1	0.852	0.693
75	7.5	11 98				1	0.909	0 775	0.630
90	9	11.07			1	0 924	0 84	0 717	0 582
105	10.5	10 4		1	0.939	0 868	0.789	0 673	0 547
120	12	9.9	1	0.952	0.894	0 827	0.752	0 640	0.521

NON-CONDENSING ENGINES.
Assumed back-pressure, 16 deg. above zero.

Initial Pressure above Zero.	Rate of Expansion.	Pounds of water per H. P. per hour.	Ratios of Economy.						
60	5	25.7	1						
75	6 25	21 6	0 84	1					
90	7.5	19 0	0.74	0.88	1				
105	8.75	17 27	0.672	0.80	0.91	1			
120	10	16	0 622	0.74	0 842	0.926	1		
150	12.5	14 2	0.552	0.657	0 747	0.822	0 888	1	
180	15	12.97	0 504	0.60	0.68	0.751	0.81	0.91	1

This shows how the gain to be derived from expansion decreases

as we approach higher pressures, and how, at a certain point, it may be absorbed entirely by losses arising from condensation, radiation, clearances, etc., which increase with higher pressures and greater ratios of expansion. J. C.

Editors POLYTECHNIC REVIEW:

In your notice of Mr. Bramwell's pamphlet on the steam engine, you seem to endorse that gentleman's contempt for the compound engine; but I think you must admit that Mr. Bramwell has not made a fair comparison in taking as an example of *expansion in a single cylinder*, a double-cylinder engine, cutting off at half stroke, with cranks at 90 deg., and *for compound*, the antiquated Woolf engine, acting on *one* crank. No wonder the diagram of rotative force shows better for the first engine; and it must also be borne in mind that a single cylinder, cutting off half stroke, would use a good deal more steam than the compound given here.

In a fair comparison the rate of expansion and the disposition of cranks ought to be the same for both types, and it will then be easily seen that the compound engine—

1. Has less initial pressure on its working parts, which can thus be made smaller and lighter, whereby a saving of work for friction, wear, and lubricants is effected.

I have frequently found that engineers in charge of single-cylinder expansive engines would carry lower boiler pressure, cut off later, and thus burn more coal. When asked why economy was thus set at naught, they would answer, that with high pressure and short cut-off their engines would knock themselves to pieces, and always give them hot bearings or other troubles. This shows that the above claim has practical facts for its foundation.

2. In compound engines the pressures will be more uniform throughout the stroke, giving a greater uniformity of rotative force, which is of special importance in marine engines, where no fly-wheel can be used.

I had a practical illustration of this fact when, in 1871, I was present at the trial of a steamer belonging to a Liverpool company, which had just been converted into compound by having a high-pressure cylinder placed on top of each of the old cylinders (two in number), which latter were then used as low-pressure. The saving in fuel was about 30 per cent.; the indicated horse-power was *the same* as before the conversion, but the greater uniformity of the rotative forces increased the speed of the vessel from 10 (before conversion) to 11 knots per hour.

Considering the above as "mechanical" advantages of the compound system, I will now enumerate those that might be called "physical." Among these the greatest and most important is diminished condensation. The interposition of a low-pressure cylinder between the fresh steam from the boiler and the condenser is only a logical sequence of Watt's invention of a separate condenser, the latter not being sufficient for the high steam-pressures now in use.

Steam of 60 lbs. pressure, expanding six times in a single cylinder, would give a range of temperature of 307 deg. minus 141 deg. equals 166 deg. In a compound engine with cylinders 1 to 3, cutting off at half stroke, in the first cylinder there would be the same rate of expansion—6; taking about 17 lbs. as the pressure between the cylinders, the extreme differences of temperature would be, in the first cylinder 307 deg. minus 220 deg. equals 87 deg., and in the second cylinder, 220 deg. minus 141 deg. equals 79 deg. Taking the diameter and stroke of the high-pressure cylinder as equal to 1, its total surface would be—

Two ends	1.5708
Circumference	3.1416
	4.7124

and that of the low-pressure cylinder—

Two ends	4.7124
Circumference	5.4412
	10.1536

That of the single cylinder would be the same—10.1536.

Multiplying the surfaces exposed to condensation by the respective differences of temperature, we find the following:

Compound Engine.

$4.7124 \times 87 = 410$
$10.1536 \times 79 = 802$

Total 1212

Single-Cylinder Engine.

$10.1536 \times 166 = 1685.5$

The gain by the compound engine would thus be

$$\frac{(1685.5 - 1212) \times 100}{1685.5} = 28 \text{ per cent.},$$

if it is assumed that the condensation will vary as the surface exposed and the difference of temperature.

Another advantage in the compound system is to be found in the diminished influence of clearance spaces, so that no excessive compression is needed to obviate any loss therefrom, as in single-cylinder engines. The steam in the high-pressure clearance does its share of work in the low-pressure cylinder, and in the latter the difference of initial and back pressure is comparatively small, so that very little compression will prevent any loss by clearance.

Of course, none of the latter advantages can be claimed for the old Woolf system; they can only be attained by the modern independent compound engine, with intermediate receiver and a suitable adjustment of valve motion. J. HAUG, M. E.

In reply to the above we have only to say that the discussion of the principle of compounding against its numerous advocates would be a task which, in view of our present excess of work, would be not only a tax, but almost an impossibility. We are very well content to place ourselves again on record as opposed to the principle of compounding, or rather as advocating in preference the duplex system. We hope to have time, at no very distant day, to present diagrams and figures in support of our opinion, and in contradistinction to that held by a vast majority of engineers. Still, as Mr. Haug's letter has due it the courtesy of a reply, and his standing as an engineer would entitle any opinion of his, whether orthodox or heterodox, to respectful attention, we may say, concerning his valued communication, that we believe that the Bramwell diagram of coupled engines cranked together at the quarter stroke would, even if amended from cutting off at half stroke to eight-fold expansion, as in the case of the compounded engine, cylinders 1 to 4, and cutting off at ⅛, show no very unfavorable contrast, as regards steadiness of rotative force, with the diagram of the latter. We fail to see how the compound engine, with the same steam pressure, can have much less initial pressure on the working parts than the quarter-cranked duplex.

As regards the engineers who found their *single*-cylinder expansive engines knocking themselves to pieces at high pressure and short cut-off, and who lowered the pressure and cut off later to remedy this trouble, we do not see that the case has any bearing upon the question of compounded *vs.* duplex cylinders. Both compounding and coupling are means of steadying the irregular and injurious action of single-cylinder engines. The case cited seems to us to be only an argument against single cylinders.

The case cited by Mr. Haug of his marked improvement in steadiness of the duplex engines of the Liverpool steamer by compounding each cylinder, giving four cylinders in all, does not strike us as being any special point in favor of compounding *vs.* doubling. The compounded duplex engines had *four* cylinders to steady the rotation, and higher grade of expansion, to effect economy in fuel; and we maintain that the improvement made was a good one, but no better than would doubling the number of high-pressure cylinders, and cutting off proportionately earlier, have been. The steadiness of three-cylinder and four-cylinder non-compounding engines is well known.

Regarding the purely physical advantages claimed for the compounding principle, we would say, as regards the diminished condensation claimed for the compounded over the duplex cylinders, all being of the proportions chosen by Mr. Haug, that if the loss by cylinder condensation were any important percentage of the amount of force stored up in the coal consumed, or even of that in the steam delivered to the cylinders, a saving of 28 per cent. of that percentage might be worth considering. The matter of clearance is being reduced to a minimum, and will soon become a trifle which, like that from condensation, will show very little in the coal pile.

The idea of compounding having taken hold of the minds of the most eminent engineers has been worked out almost to its finest degree, while the duplex system, having no such delusive and attractive claims as to getting power twice out of the same steam (which was really the idea of the first engineers adopting the compounding principle), has been comparatively neglected. The same ability, experience, and facilities that have enabled the builders of compounded engines to proudly point to an efficiency rating of *ten per cent.* of the theoretical power of the fuel which drives them, would, we have no doubt, if expended in proportioning and otherwise improving the duplex non-compounding engine, have utilized much more than a tithe of the material used as fuel.

Furthermore, we believe that the record of some non-compounding engines, as those of the Cromwell line of vessels (built by Messrs. Pusey, Jones & Co., of Wilmington, Del.), will compare more than favorably with that of the average compound engine, and perhaps will not suffer by comparison with that of the very best types and instances of the compound.

There are matters not replying to the points referred to in Mr. Haug's communication, and which we deem very well worth keeping until time permits us to properly argue against the compounding and in favor of the duplex system. Until then, we are very well content to be placed on record as a "non-compounder." G.

SELECTED LIST OF U. S. PATENTS.

JUNE 26TH, 1877.

Patents issued June 26, 1877, 235. Reissues, 8. Trade marks, 39. Designs, 11. Labels, 10.

192,322. PLANING MACHINE. W. W. Brewster, Revere, Mass.

This machine has a horizontal rotary cutter, whose axis is transverse to the machine bed. The lumber while being planed, is held flat upon the bed, and the tendency of the cutter to draw the lumber toward said cutter, or upward from the bed, is obviated by means of a pressure shield, formed of a series of crescent shaped sections pivoted upon a rod passing through the main frame behind the cutters, and pass over the cuttter cylinder near its cutting edge. An elastic pressure roller is mounted above these sections, and produces the requisite pressure of the sections upon the board.

All are mounted in a pivoted and vertically adjustable cylinder frame.

192,352. WOOL COMBING MACHINE. Leonard Smith, Bradford, England.

In addition to the ordinary combing and drawing off mechanism, an auxiliary comb and a transferring-lifter are used, whereby the "noil" remaining in main comb is transferred to auxiliary comb, with the long wool therein presented in proper position for removal. An auxiliary drawing off mechanism is also used in connection with the auxiliary comb. In some cases it is desirable to heat the auxiliary comb, and it may therefore be hollow or steam tight.

192,385. MACHINE FOR MAKING PAIL BOTTOMS. G. W. Parker, Gardner, Mass.

The blanks from which the pail bottoms or barrel heads are to be formed are placed in an adjustable hopper upon the top of the machine, and fed forward by means of a feeding piece operated by a longitudinally reciprocating tongue piece between vertically adjustable plates, where the blank is firmly held while the bottom or head is cut and beveled by suitable cutters attached to heads, arranged upon a slotted rotating plate mounted upon the upper part of a vertically adjustable tubular shaft provided with a pulley, and rotating upon a vertical rod passing under a tubular stand plate upon a cross piece in the lower part of the frame.

192,401. PROCESS FOR SEPARATING COPPER AND THE PRECIOUS METALS FROM COPPER MATTE. Wm. B. Young, Golden, Col.

The pulverized matte is roasted with common salt, and the chloride of copper is dissolved out with water. The residue is smelted with lead ores to obtain gold and silver bullion.

192,402. BENCH PLANE. C. L. Adancourt, Lansingburg, N. Y.

The body of the plane is provided with adjustable extension sections attached to its ends for the purpose of increasing the length of its bearing surface. A reversable cutting bit is attached by a slotted opening to, and rests upon, a hinged bank supported upon trunnions in the side walls of the plane, and the lower ends of the bank and bit are raised or depressed by means of an adjustable eccentric pivoted to the base of the plane and provided with a suitable handle.

192,424. STOP-MOTION ATTACHMENT FOR SPOOLING MACHINES. Francis Fearon, Philadelphia, Pa.

When a thread breaks, its eyed bell crank lever falls and engages a fluted roller. Said roller, revolving, presses against said lever, and causes the lever frame to be turned on its pivot, thereby, through intermediate mechanism, causing the elevation of the long levers, so that they strike the journals of the spool and lift the same clear of the driving drum.

192,427. MOWER AND REAPER KNIFE SHARPENERS. Zarda Frost, Kinmundy, Ill.

The knife holder is jointed to an adjustable base, and is thrown forward to the stone by a treadle, and away from it when released by a spring. The holder and its base are adjustable in a horizontal arc which may be graduated.

192,431. BRICK MACHINE. W. L. Gregg, Philadelphia, Pa.

The top plate, after pressure is given to the brick, is raised above the top of the mould box, while the plunger also moves upward, and carries the pressed brick out of the mould, from which position it is removed by the ejecting and lubricating device. A passage leads back from the mould box to the hopper, to allow the escape of superfluous clay.

192,437. WIRE STRAIGHTENING MACHINE. Irving A. Kilmer, Cobleskill, N. Y.

This is a double machine having duplicate devices at each end and a mediate carriage for taking two wires, one from each end roll toward the other end of the machine, and straightening and cutting off any desired length of each wire. There are forward and backward clutches; the former to arrest the forward movement of the wire at the proper moment, and the latter to prevent a backward movement of the same. The carriage seizes the end of one wire and draws it out through guide and friction rollers whereby it is straightened, and then into a die under a cutter and in a sliding cross head. The other wire is seized and similarly treated by the counter movement of said carriage. The carriage continuing to recede to the left not only draws the second wire to the left, as before the first wire was drawn to the right, but also by a cam on it striking a lever actuates a cutter to cut from the first wire the straightened portion, which falls free from the machine. And so on alternately. Should either wire fail to unwind, its reel moves inwardly and shifts the driving belt on to a loose pulley, and stops the carriage.

192,439. PEN HOLDER. Story B. Ladd, Washington, D. C.

The handle is hollow and provided at its end with a plug having a helical slit or socket to receive the pen, whereby it is enabled to receive and hold pens of different sizes or curvatures.

192,444. RULING MACHINE. J. McAdams, Brooklyn, N. Y.

A rock shaft which carries the pen lifter, provided with a cam wheel, is also provided with an arm extending back under the front edge of the pen bar, and has an anti-friction roller, upon which a set screw or pen bar impinges, and by means of which the pressure of the pens upon the paper can be regulated. The rock shaft also carries a slotted block, through which the pen lifter passes, and rests upon the bottom of the slot, having the form of the double inclined plane, whereby, through set screws, the lifter may be adjusted, relative to its pressure upon the cylinder.

192,473. SPINDLE. Gilbert P. Whitman, Rockport, Mass.

The bobbin is seated in a tapering cup, formed on the upper portion of the whirl, and is supported at the upper end by a small spindle which is loosely inserted in the top of the post.

192,482. LOOM PICKERS. John W. Barlow, Lawrence, Mass.

The covering sheet is provided with a separate layer at each edge, and with a groove.

192,492. SPINDLES AND BOBBINS. Geo. Draper, Hopedale, Mass.

The spindle, for some distance above the top of the bolster, is made cylindrical rather than tapering, as usual, whereby the spindle at the top of the bolster is so strengthened that it may be rotated at increased speed without vibration. The bobbin has a single friction adhesive bearing upon the extreme top of the spindle, increased in size to afford a frictional surface of sufficient extent to drive the bobbin at full speed.

192,510. DELIVERING APPARATUS FOR PRINTING MACHINES. Richard M. Hoe and S. D. Tucker, New York.

The sheets from the female cutting cylinder, which is also the second impression cylinder, are directed by rigid guides to a grooved cylinder on which they are held by tapes until a determined number are collected, when a switch is rocked into the grooves to throw off the mass which passes down before the fly.

192,514. LET OFF MECHANISM FOR LOOMS. Daniel E. Keating, Lowell, Mass.

The supporting arms of the whip roll are extended rearwards, and upon these extensions weights are suspended between the fulcrum rod and the whip roll; there is secured to one of said arms a vertical rod carrying a catch pawl. The shaft which carries the worm and ratchet is mounted in a pivoted frame, held to the loom framing by a spring catch. When the aforesaid frame is so held, it is in position to operate the beam. The vertical arm has a projection adapted, when there is an extra strain on the warp, to strike the said catch or latch, and disengage the worm shaft frame and throw the worm out of operation. The weight holds the whip roll up against the under side of the warps with an unvarying pressure. The descent of the roll sets the pawl, and the weight operates the said pawl to positively let off the warps.

192,527. MACHINES FOR CUTTING SUGAR CUBES. Christopher Raetz, San Francisco, Cal.

There are two sets of saws set at right angles to each other in a throat through which the sugar loaf descends. These saws divide the sugar into rectangular strips, and these are divided into cubes by a double edged reciprocating knife working below the saws. Tables on the frame of the knife catch the cubes as they fly off.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, JULY 28, 1877. NO. 4.

WOODEN PULLEYS.

We have paid special attention, in the POLYTECHNIC REVIEW, to the transmission of power by wrapping connectors, as the mode most widely adopted, especially in this country, and as giving nearly noiseless action, with the advantage that, in case of stoppage by obstruction, such wrapping connectors slip, and thus prevent the damage which would ensue where a more positive mode of transmission was employed. The desiderata in such mode of transmission are, a maximum of friction between belt and pulley face and a minimum of journal friction. We attain the latter point by suitable bearing metal and by large bearing surfaces; and the first by embracing as large an area of the pulley as possible with the belt, and by choosing belt and pulley surfaces which give a maximum of friction.

Where rubber belts are used, we choose such as have a smooth and glossy surface, which will bed readily down to the pulley face. Where leather belting is employed, we run it with the grain side down. The ordinary cast-iron pulley, with its face turned smooth or worked down with a grindstone, does not afford as high a degree of friction as is desirable, and its efficiency is improved markedly by giving it a facing or covering of leather or of paper. In most cases, however, we find that we may with advantage employ wooden pulley faces to increase the desirable friction or adhesion; and by making the web of wood, we may employ a larger pulley with the same weight, or, where the speed calculations necessitate a given diameter, may lessen the weight upon the shaft, and allow smaller shaft or greater distance between hangers. A further advantage of the wooden pulley is the reduced width of belt required to transmit a given horse-power without slip.

The following tables from Haswell and Morin, giving a comparison between iron and wooden-faced pulleys with leather belts, are interesting to note in this connection:

Portion of circumference embraced by belt.	Relative value of Leather Belts.	
	On Wooden Pulleys.	On Iron Pulleys.
.20	1.80	1.42
.30	2.43	1.69
.40	3.26	2.02
.50	4.38	2.41
.60	5.88	2.87
.70	7.90	3.43

Morin: *Appletons' Encyclopædia of Mechanical Arts.*

Portion of circumference embraced by belt.	Relative value of Leather Belts.	
	On Wooden Pulleys.	On Iron Pulleys.
.20	1.80	1.40
.30	2.40	1.70
.40	3.30	2.00
.50	4.40	2.40
.60	5.90	2.90
.70	7.90	3.40

Haswell: *Engineers' and Mechanics' Pocket-Book.*

Haswell, an acknowledged authority and much quoted by American mechanics, summarizes thus: The ratio of friction to pressure for leather belts, when worn, over wooden pulleys is .47; over turned cast-iron pulleys, .24.

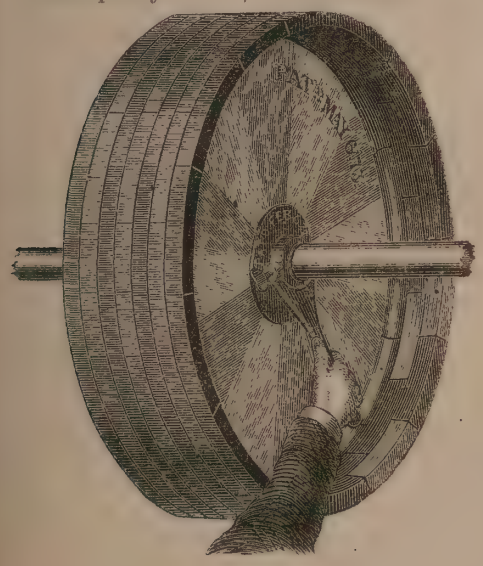


Fig. 1.

Fig. 1 shows a pulley built up entirely of wood, the web being of sectors in each of which the grain is in a radius line from hub to face.

The face is built up of rings on either side of the outer edge of the web. The entire pulley is turned true and smooth, and then filled with a hard filler and coated with shellac, in order that they may be unaffected by atmospheric influences or by ordinary changes in artificial temperature and dampness. In this connection the makers* of the pulley illustrated employ a taper fastening worthy of illustration herewith.

The intention is to obviate the decentering and unbalancing of a pulley consequent upon the employment of a radial set-screw through the hub, while at the same time doing away with the danger attendant upon the set-screw catching belts or clothing, and also avoiding the marring of shaft either by burring, as with set-screws, or by key-ways.

Fig. 2 shows in section and Fig. 3 in perspective a wooden pulley with taper-sleeve fastening; *G* being the web, *H* the rim, *D* the shaft; *A* and *B*, annular plates or flanges clamping the web and having pins to render their hold more positive. *J* is a shoulder on plate *A*, and on this the web bears; and in all sized flanges for large and small shafts this is of the same diameter. *K* is a centering shoulder for the aperture *L*, in the female flange *B;* and it projects far enough through the web to enter the flange *B*. The parts being brought together, the nut *E* is screwed up by means of the wrench *O* upon the screwed split sleeve *C*, causing it to bear uniformly upon the shaft.

* Taper-Sleeve Pulley Works, Erie, Pa.

As the principal disadvantage resulting from the use of wrapping connectors is the slip and the consequent impossibility of obtaining constant velocity ratio and

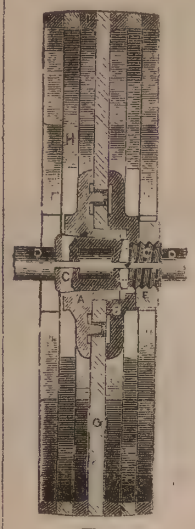


Fig. 2.

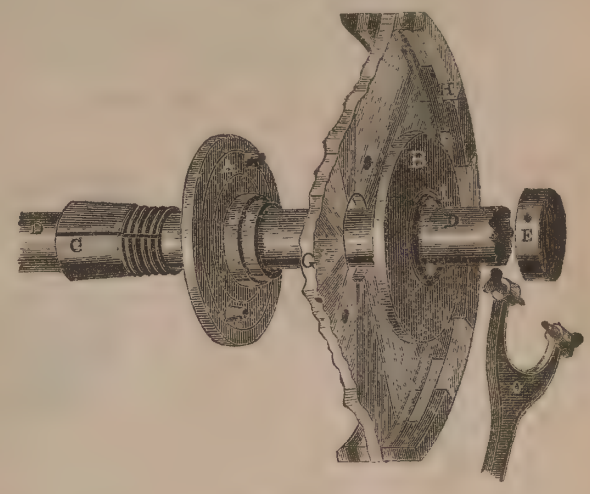


Fig. 3.

undiminished power, the wooden-faced pulley has special claims upon our attention. Some of the advantages of a taper fastening over a set-screw have been alluded to in a previous paragraph; another point may be mentioned: that where a set-screw is employed, the pulley is in many cases eccentric, and is always so when there is the slightest variation between the size of the shaft and the bore of the pulley. With the taper-sleeve fastening, a slight variation would be no detriment, as the sleeve wedges the pulley to the shaft concentrically, and it would be almost impossible to decentre the pulley in the act of fastening.

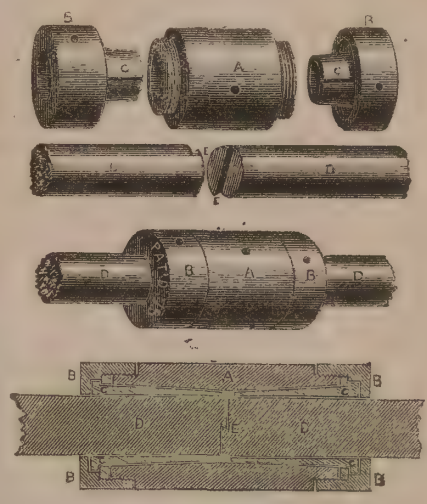
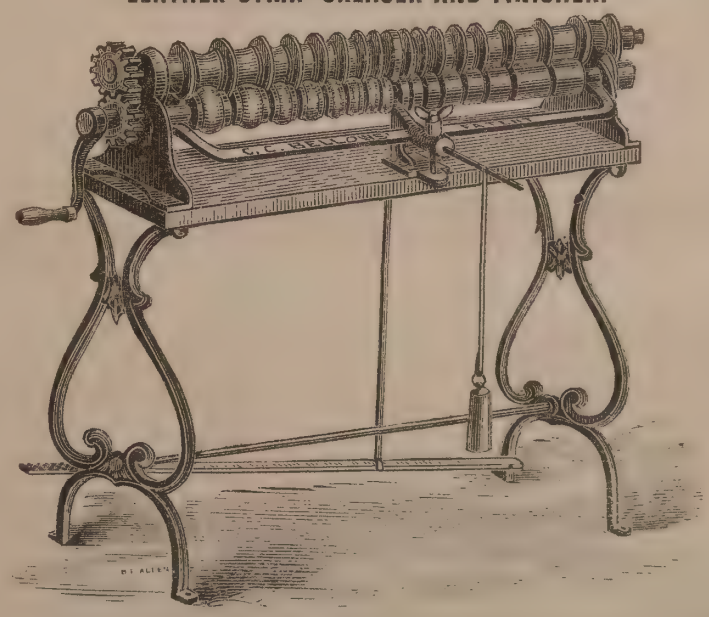


Fig. 4.

The same parties make use of the taper-sleeve principle in the manufacture of a coupling, herewith shown. The application of this principle is unlike its use on the pulley, in that the coupling has two flanged sleeves, *C C*, and the sleeves are contracted to the shaft *D*, within the threaded coupling-hub *A*, by the threaded ring nuts *B B*. Each shaft has its independent sleeve, and is secured concentrically with the other without reference to any difference in their diameters. There are no keys, set-screws, bolts or pins used in this coupling, and it can be coupled and uncoupled with the utmost rapidity.

G.

LEATHER STRAP CREASER AND FINISHER.



The cut shows a machine excellently well adapted for the purpose of creasing and ornamenting heavy straps of any width and thickness. The address of the patentee, C. C. Bellows, has been mislaid, which we regret, and which could not have happened had he been a subscriber to the REVIEW.

G.

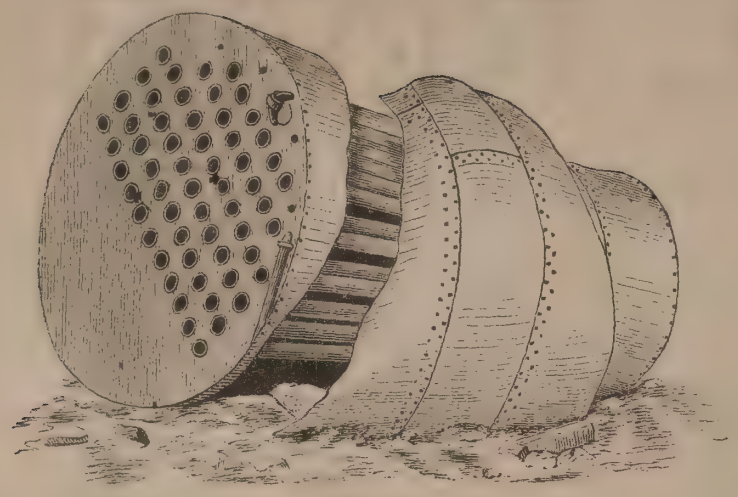


Fig. 11.

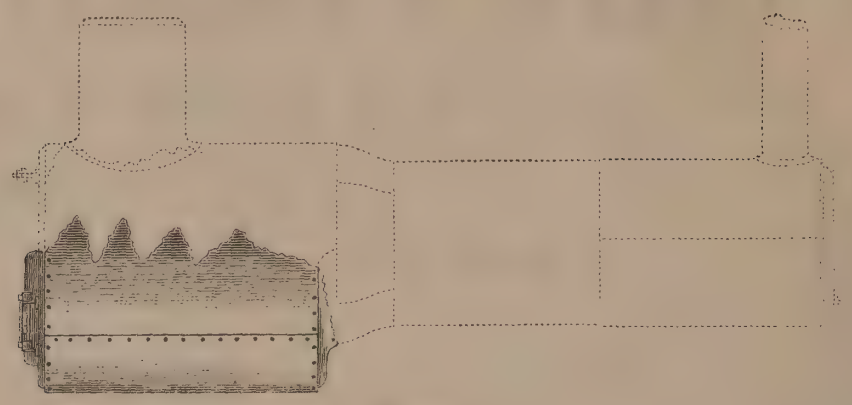


Fig. 12.

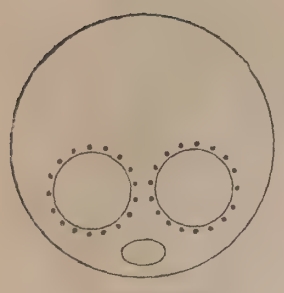


Fig. 13.

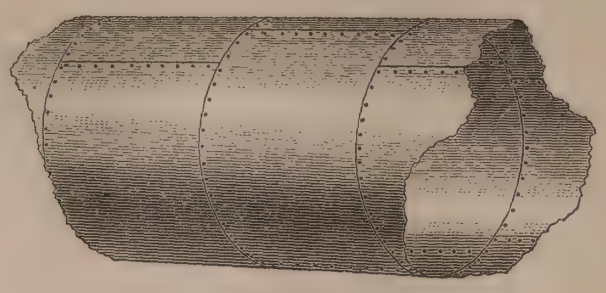


Fig. 14.

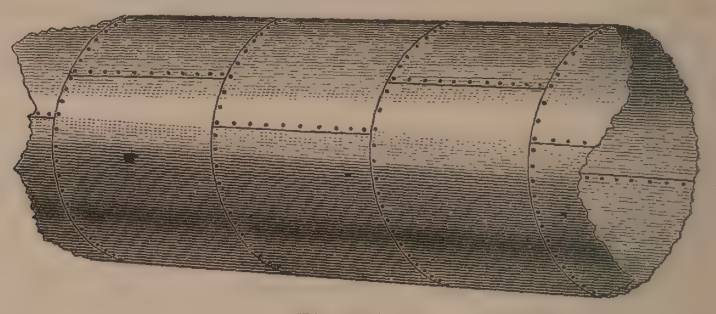


Fig. 15.

Fig. 16.

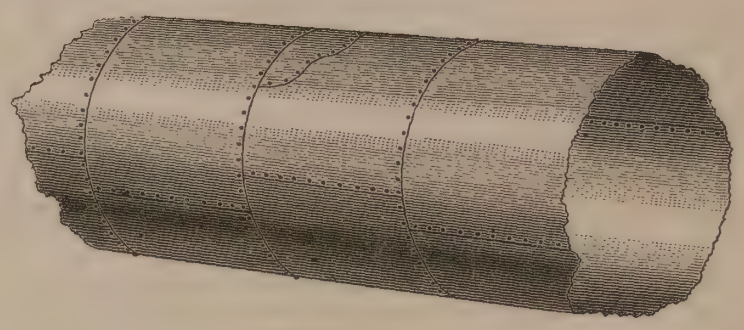


Fig. 17.

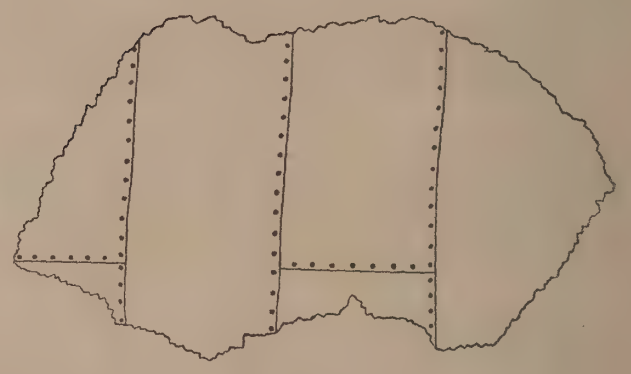


Fig. 19.

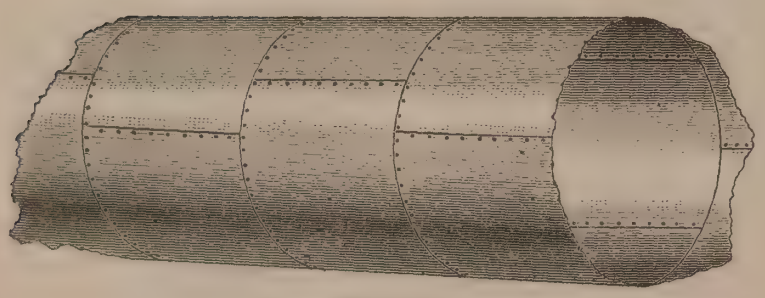


Fig. 18.

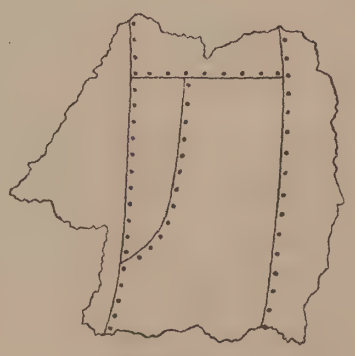


Fig. 20.

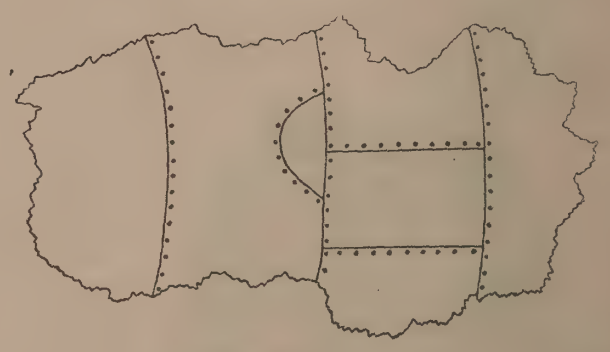


Fig. 21.

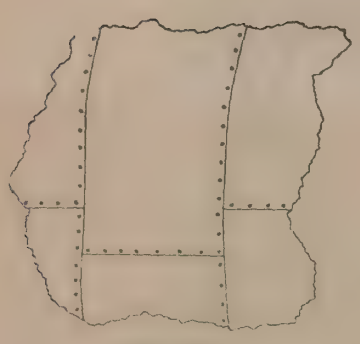
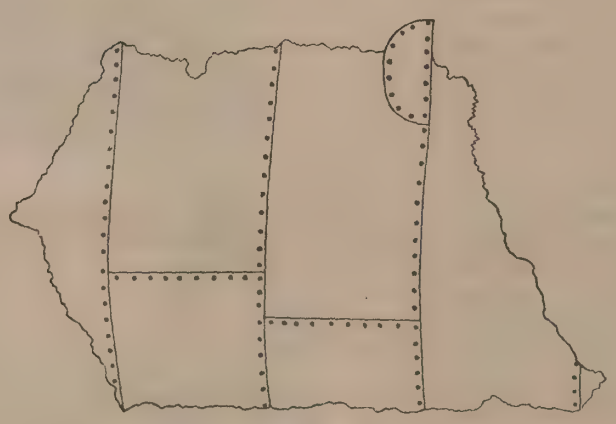


Fig. 22.



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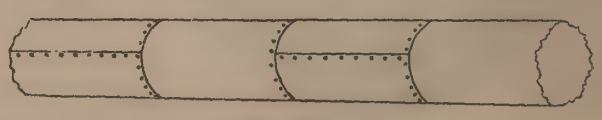

Fig. 26.

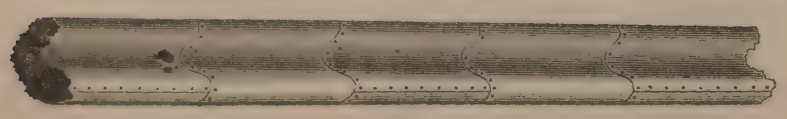

Fig. 24.

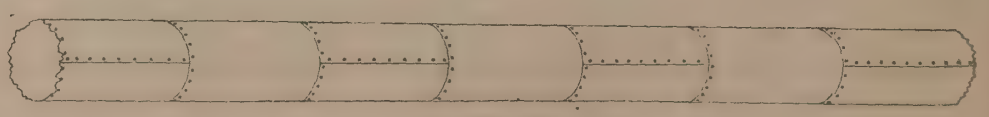

Fig. 25.

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

ANNUAL REPORT OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

III.

A boiler used in a wood-working establishment exploded, damaging itself seriously, as will be seen by Fig. 11. The boilers in the battery with it were more or less disturbed; the fireman was killed.

An examination revealed the fact that the water had been allowed to get low. The glass gauge indicated water at the proper level a short time before the explosion, but there was unmistakable evidence of burning in the lower part of shell and back head. Glass water gauges are not always to be relied upon. If the water is foul, connections are liable to get stopped. The gauge cocks should never be neglected.

A portable boiler which had been inspected by this company, in the yard of the builder, and on which a guaranteed certificate had been issued, exploded in November. This boiler was used in connection with a saw-mill. The destruction was most complete. Our expert, who visited the scene, wrote: "Gunpowder or even dynamite could not have made the destruction more complete; there isn't any boiler left to make a sketch of." He did, however, give us enough to make Fig. 12.

What the conditions were which caused this accident I am unable to say. The boiler was nearly new, well constructed, of good material. It is fair to presume that the boiler was neglected, and overheated.

A terrific explosion occurred in one of the large rolling-mills in the country, the latter part of the year, by which twelve persons were killed and nine persons seriously injured. The boilers were of the flue type, twenty-eight feet long, forty-five inches in diameter, made of quarter-inch iron. The flues were each fifteen inches in diameter. The county inspector of steam boilers had tested them shortly before, and allowed them to be run at a pressure of 105 lbs. to the square inch. It was stated that the boilers were running at a pressure of 125 lbs. per square inch at the time of the explosion. Fig. 13 shows the head of one of the boilers.

The boilers had been used for some years, and had been patched in several places. In estimating the strength of boilers we are accustomed to ascertain from diameter of boiler, thickness of iron, and tensile strength of iron, what the resistance to a bursting pressure is, or, in other words, at what pressure will the boiler explode? Following Fairbairn's rule, we then allow but one-sixth of the bursting pressure as the safe working pressure. The margin is large, but in our opinion it should always be on the side of safety. Where the tensile strength of the iron cannot be ascertained by actual experiment, we allow, for first quality of iron, 42,000 lbs. as equal to the strength of riveted plates containing one inch of sectional area.

These figures would give, for a boiler forty-five inches in diameter constructed of quarter-inch iron, about eighty pounds as the safe working pressure. The explosion above referred to was very destructive to the boilers, as will be seen from the following figures. Some portions of the boilers were thrown 300 feet. Flues were collapsed, and general destruction was the result.

Fig. 14 shows a portion of the boiler which was thrown some 135 feet. Figs. 15 to 26 illustrate portions of the boilers found in the vicinity. That shown at Fig. 15 was thrown about 75 feet; the remaining ones about 300 feet.

The loss by this explosion was variously estimated at from $10,000 to $20,000. The boilers were not insured. This case gives a vivid picture of the terribly destructive power of steam when it gains the mastery.

[*To be continued.*]

ERRATUM.—In the article on the Slide Valve, in last number, second column, 13th line, "fractional" should be *frictional*.

A NATIONAL IMMIGRATION BUREAU.

The Fairmount Park Commissioners have given the use of Machinery Hall, in Fairmount Park, for the establishment of a National Immigration Bureau. In this building there will be exhibited, free of charge, all contributions the different States and Territories may see fit to make. These are expected to embrace specimens of minerals, vegetable products, manufacturers, works of art; the laws, statistics and rates of taxation of the different States; maps, charts, and full descriptions of lands for sale; together with an abstract of titles and specimens of all kinds, that will represent the resources of each State and Territory, so as to enable the manager of the Bureau to answer any question emigrants may want to ask.

The object of this Bureau is stated to be to foster and encourage immigration in all the States and Territories that desire it. Hence they should all be represented. Specimens of their resources should be on exhibition for the enlightenment of emigrants who are selecting new homes.

The manager says that every route, by sea and by land, to and from all the States individually and collectively, will here be presented to view as fast as received, and the rates of fare and other particulars given when required.

Parties having inducements to offer immigrants, should be full and explicit in their descriptions, so as to be readily comprehended. Those who have lands to offer cannot be too particular in giving locations, descriptions, titles, prices, character of soil, etc.

The authorities in all the States and Territories should readily see the importance of being represented in this Bureau, and of placing on exhibition specimens of their resources. There is abundant room for all exhibits, and all will be shown to the best advantage.

While this is a private business enterprise originated by Mr. Lee Crandall, as a mammoth real estate agency, the boldness and scope of the undertaking warrant us in calling to it the attention of the public. If properly managed it can be a power for good in developing the resources of our country. If extortion or partiality are practised by employés or others, it will more the less bring upon the enterprise and upon the community curses loud and deep.

THE MANUFACTURE OF JEWELRY.

I. The love of personal embellishment and ornamentation is found developed even in the lowest grades of civilization. In the remains of primitive man, we ever see the attempt, crude and rudimental enough at first, but still the unmistakable desire to combine with the useful such adaptation of shape and form, which, without detracting from their strength and durability, serve to give them symmetry and grace.

In tracing the progress of man towards civilization, we find that with his development, his conceptions of the beautiful advance in the same ratio. Where at first he was pleased and satisfied with the rude embellishments which his limited resources enabled him to bestow upon his habitation and implements, as his resources enlarged themselves his tastes underwent the same improvement. Those things which were pleasing to him in the infancy of his race, became hideous to his more refined taste. The rude carvings on his tools, and the roughly shaped ornaments with which he was wont to deck himself, no longer satisfied him; he improved and bettered their shape, and as from age to age he became acquainted with one metal after the other, he substituted these in the place of the stones and wood which had before been his only materials.

To the insular condition of the different races, the difficulties of communication, and the constant inroads of the barbarians upon the semi-civilized colonies who first practiced the use of metals, made close union for mutual defense necessary, and to this is doubtless due that vast difference in style and execution which has always distinguished the labors of Egypt, India, Etruria, Greece and Rome.

The valley of the Nile was the cradle of primitive art, and from here as a centre, it spread itself over Asia and Europe. The peculiar style of Egyptian art is due partly to their isolation from outward influences and their high esteem and reverence for things sacred. In all their works the lotus, the iris, the sphynx, and other sacred objects play the most conspicuous part. Added to this is the strange neglect which they showed to the laws of perspective, and their flat style of execution.

To the productions of the East no fixed rule of style can be given; nor can their labors be judged by any of the standards by which modern art passes judgment.

Modern ethnology ascribes to the Etruscans the development of art upon the proper basis; though their earliest efforts bear the unmistakable impress of their Asiatic origin. To them does Europe owe its first impetus to true art; from them doubtless, were derived the arts of ancient Greece, which can be proven by the remains of Grecian colonies in Southern Italy.

The Roman style, austere and massive as it first was, received great improvements for the better from the conquests in Greece. In all their fine arts and their architecture they owe much to Hellenic culture.

II.—With all the advantages which recent scientific discoveries should give the modern jeweller, his productions can not compare in point of art with that of the ancients.

Although he can now avail himself of more advanced means; though he introduces the punch and press, the burin and chisel, castings, galvano-plastic, enamel, niello, and many other more modern appliances, his work is far more mechanical, and wants that grace of finish and delicacy of design which makes the remains of the Etruscans and Phœnicians beyond the power of imitation. Then, not as now, the excellency of the workmanship, rather than the intrinsic value of the material employed, was what was esteemed. The extreme lightness of some of the art productions in gold, the minuteness of the particles, the small grains and rope-work that could scarcely be distinguished by the naked eye, require the most consummate skill and methods of uniting and severing the pieces, of which we no longer have any knowledge.

Their designs, free from the severe and geometrical shapes that have now found sole and universal acceptance, embrace the free and unbridled fancy of the artist, uniting with the imagination such object studies, adaptations of plant and animal forms and mythological symbols, as the artistic eye and good taste of the workman prompted.

Recent research into the means employed has brought many of the long forgotten secrets to light. Among the first who were in any way successful was a Neapolitan, named Sarno, famed for the very clever imitations of Pompeiian and Herculanean jewelry. So skillfully were some of these executed that he frequently duped even those archæologists whom long experience had made almost infallible. About 1830, the elder Signor Castellani opened a studio in Rome where many re-discoveries were made, and among other things, a very extensive treatise on the chemical coloring of gold.

In the Italian Department of the Centennial Exhibition, Alessandro Castellani, his son and successor, exhibited some excellent reproductions of Grecian, Etruscan and Egyptian jewelry, amongst the most noteworthy of which was the Etruscan crown of the Louvre, and the Milo necklace of the British Museum. Two very beautiful necklaces, an exact reproduction of those found at Vulci, were exhibited with his collection of antiques in Memorial Hall.

III.—The mode of manipulation employed by the ancients not having descended to us, perhaps some little explanation of the modern means employed would not fail to prove of interest to the reader.

Fine gold, both on account of its higher value and its ductility, being more difficult to work by modern processes than when alloyed with other metals, has been almost uni-

versally succeeded by alloys of a lower grade. For diamond mountings and the better order of jewelry, 18 karat gold has found general acceptance, while for jewelry in general 14 K. is used. Due to the present depression of business, alloys from 4 K. to 12 K. have been extensively employed for cheap ware.

According to the relative proportion of silver and copper added in alloying, the yellow or red color of the gold is regulated. Fine gold being taken as 24K., 18K. red gold consists of :

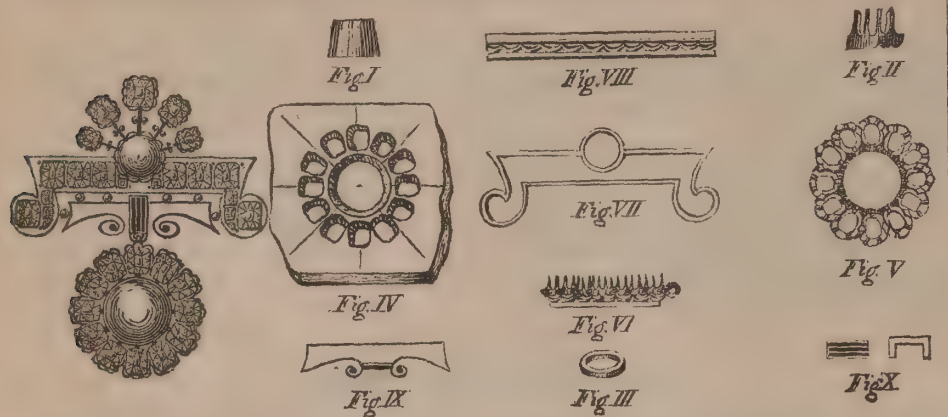
Fine gold 18 parts ;
" copper 5 1-2 "
" silver 1-2 part

24

The shade more or less red being regulated by the greater or lesser quantity of silver. For yellow gold, to the 18 parts fine gold, even quantities of silver and copper are added, and the shade regulated by copper. Green gold is made by adding to the 18 parts of fine gold, silver alone ; and blue gold, though very difficult to make, due to iron not making an intimate union with gold, is produced by adding 6 parts of iron to 18 parts fine gold. The alloys are melted in a crucible with the addition of borax as a flux, and cast into ingots—either as bars or plates. These are hammered or laminated according to the purpose for which they are intended.

The diamond mounter, or jeweller proper, [for the factory workman who works after given rules and patterns, and whose whole duty is to solder together the stamped parts that are given into his hands, scarcely merits the name,] receives the crude metal and the design, generally in the form of a drawing, and the execution is left to him.

We will select a design and follow him in its development.



Of the 2 pearls and 31 diamonds given him a brooch is to be made. The main points to be kept in view are to show off the stones to the best advantage, and, if they are perfect, to have no more gold than is absolutely necessary, so that their effect may not be marred It will first be necessary for him to make the "settings" for the stones. For this purpose, he works out a piece of gold about 3-16 inch high and at the bottom 1-16 inch thick. From this he bends the boxes for the pearl and five upper stones. [Fig. 1.] Of these he makes the settings by scalloping them out, first from the top and then from the bottom, [Fig. 2] and then solders the small frame under them for a finish. [Fig. 3.] [The solder consists of gold of a lower grade, which, melting at a less heat, firmly unites the parts between which it flows.] Having done this, he next makes the "cluster." Into a piece of gold about an inch in diameter, and 3-8 inch thick, he makes holes just so much smaller than the stones as to allow setting. [Fig. 4.] Next the outer edge of the "cluster" is finished like a setting, [Fig. 5] and scalloped "bizzle" and frame soldered under [Fig. 6.] Now he makes the mounting for the other diamonds. A frame like the contour is made, [Fig. 7] which is scalloped, and upon which a thick plate is soldered [Fig. 8] and into which the diamonds are afterwards carefully mounted. The "knife edge wire" is made from gold bent into the shape of the design and filed sharp at the top [Fig. 9]. The gold band for the enamel [Fig. 10] is so arranged that it can be secured after all the rest is finished, in order that the entire work need not go through the enamelling fire. The small shot are made by melting particles of gold, which thereby assume a globular form and retain it upon cooling.

And now all is ready for construction. This is done by placing the pieces upon a flat charcoal, applying borax and small pieces of finely cut solder to the places where the pieces are to be joined, and heating them by means of a gas jet and blow pipe till the solder "runs."

After all the soldering has been completed the work is boiled in dilute sulphuric acid, to clean it of oxide and borax, carefully trued with files, all the file-marks removed with a scraper and emery paper, and the task is ready for polishing.

This is done first by means of tripoli and oil, and afterward with rouge and alcohol. By means of gravers, rests for the stones are cut into the settings, and the gold securely pressed over their edges, and the brooch is completed.

In the manufacture of the so-called "Etruscan Ware," the delicate wire ornamentations are all bent into shape first and then soldered on the jewelry according to the design. The neat fine-gold-like appearance is produced by immersing the jewelry for a few minutes in a boiling solution of muriatic acid 3 parts, saltpetre 2 parts, salt one part. This eats out the alloy and brings the fine gold to the surface. Since it attacks copper more readily than silver, a finer effect is produced by alloying the gold with an excess of copper.

A very praiseworthy attempt has of late been made to reproduce flowers in their natural colors and details ; but due to the amount of labor necessarily expended upon them, they command higher prices than is generally invested by the majority of purchasers. It is sincerely to be wished that they may gain the approval of the public.

By the combination of platinum with red gold for seals, rings, and chains, many novel and very effective designs have been produced. In making plain linked watch chains, the links are wrapped about a mandrel having the exact shape that they are expected to assume. They are then cut apart at one end, hung together, and the joints soldered.

Oxidized silver, so much in vogue a few years ago, is made by treating silver with Ammonic or Potassic Sulphide.

Enamel is a fusible glass which is melted into cavities in the gold, made by cutting to some little depth with a graver.

Niello, lately fallen almost entirely into disuse, is a black composition of gold, silver, copper and lead heated together, and melted into a design prepared in the same manner as for enamel. The metal is then scraped and burnished, and produces the effect of a drawing in black upon a gold or silver ground.

HERMAN T. WOLF.

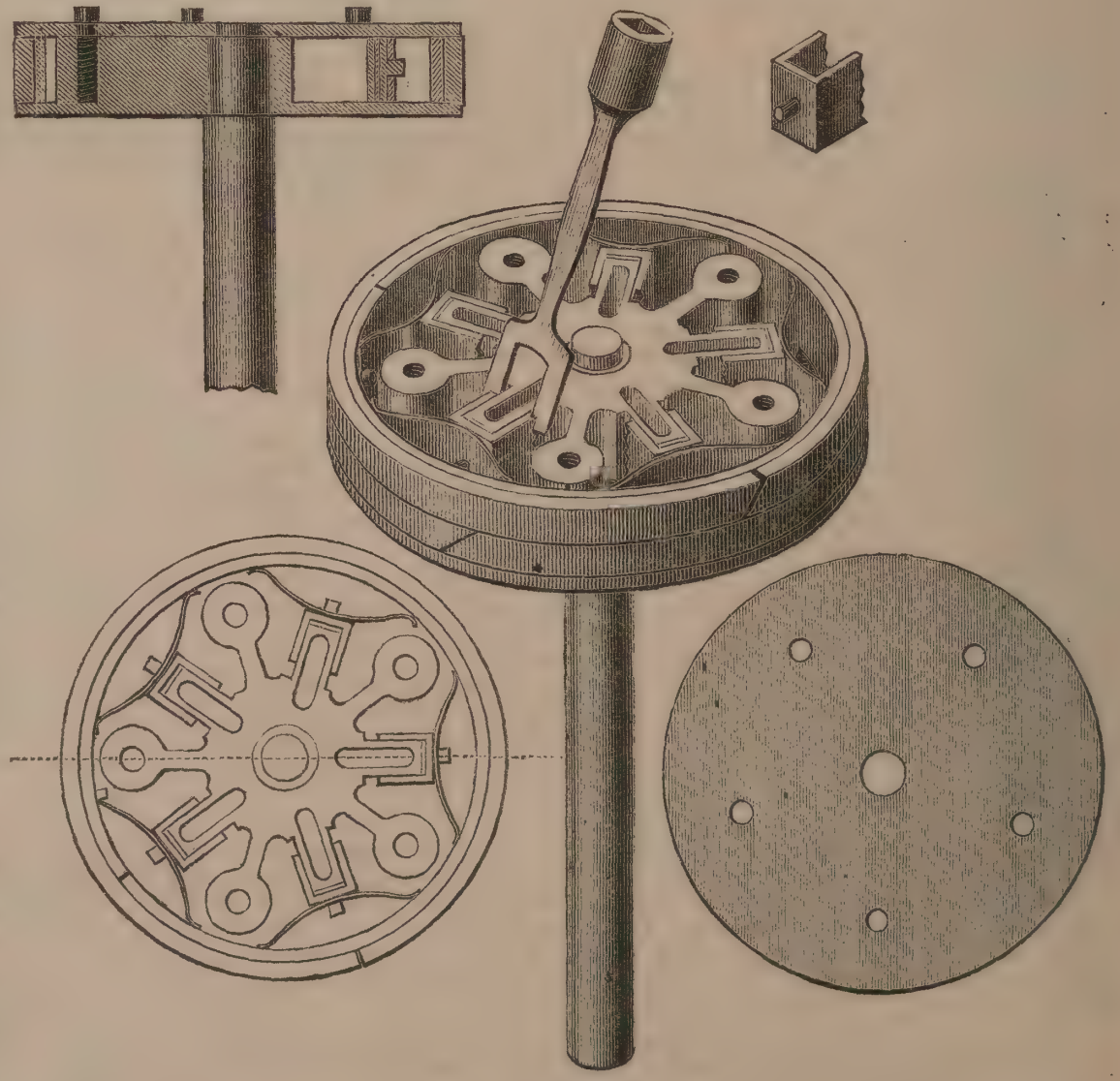
PISTON PACKING.

During the last few years, many inventions have been devised to supplant the old method of packing steam pistons, most of which have little to commend, and much to condemn their usage. Among these may be classed the "steam packing," and the so-called "solid packing." The inefficiency of steam packing is found in the fact that it unevenly wears the cylinder, wearing it larger at either end, and thereby producing an approximate hyperboloid of revolution instead of a true cylinder. This is due to the variation of steam pressure throughout the travel of the piston, which, at the beginning of the stroke, is greater than after reaching the point where steam is cut off, thereby forcing the packing rings hard against the cylinder at the beginning, and releasing the same as the pressure diminishes. In all engines using steam expansively, this must necessarily result.

Another objection is the increase of friction that must attend any increase of pressure, above that necessary to set packing out so as to form a tight joint ; any decrease of pressure will cause relaxing of packing, and leakage or "blowing" will ensue. If, for instance, a locomotive run with the throttle closed, then the packing relaxes, and the piston rides on the bottom of the cylinder, thereby wearing it out of true, and also wearing the piston rod and stuffing box glands.

The "solid packing," which is nothing more than a solid piston head, around which metallic packing rings are placed when accurately fitted, answers a good purpose until wear requires its readjustment ; then comes the inconvenience of removal, and impossibility of proper adjustment.

The packing which we here present has none of the foregoing objections, and as it embodies all the serviceable features of the "old spring packing," without its objections, it can be especially recommended. The essential feature of this packing is the manner of adjustment, which is accomplished by means of lugs and clips with liners of thin metal instead of by bolts, which were the objectionable features of the old packing, inasmuch as it was impossible to properly secure them ; and should the joint leak between piston head and follower, they become serrated or steam cut.



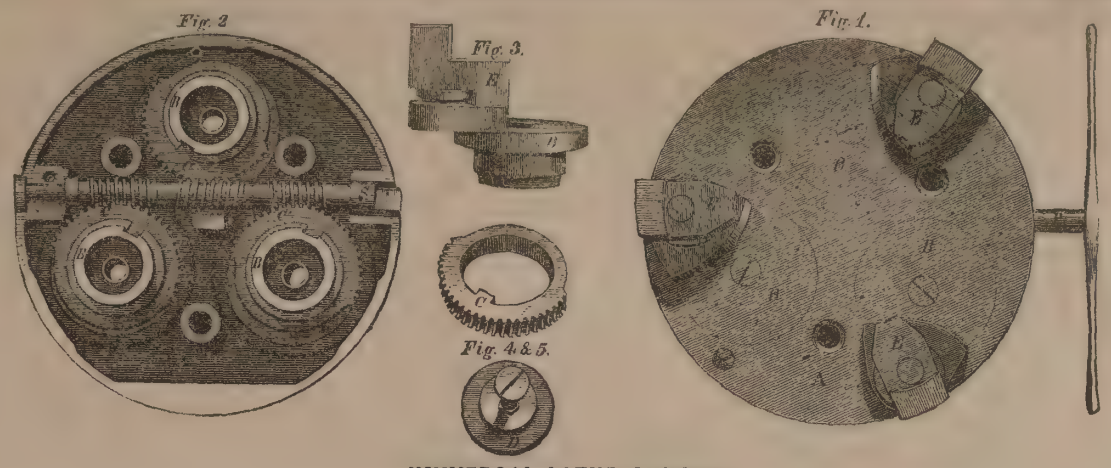
In adjusting this packing, it is necessary only to remove the follower, and set the packing rings out by means of the lever wrench, by which the clips are forced off their seats, and pieces of thin metal inserted. If the metal is not at hand, thin pieces of hard wood will answer the purpose. An inspection of the cut will explain itself. The lugs and clips can be inserted in old piston spiders if desirable.

Engine No. 219 of the P. & R. R. R., the pioneer engine upon which this packing was placed, made a mileage of 40,000 miles during the first year of its use, during which period the packing was adjusted three times. It has been adopted by the Reading Railroad, and after long and thorough tests, adopted by other leading railroads. It is applicable to all steam engines.

S. F. P., Jr.

[Patented by J. Richards, M. of M. G. & N. Branch P. R. R. R. Made by Geo. W. Waitt, Chestnut Hill, Pa.]

The report of the American Consul at Stuttgart strongly favors the feasibility of opening a market for our manufactures in Germany. The *North American* thinks that this should not be overlooked, as American trade marks are preferred.



UNIVERSAL LATHE CHUCKS.

The desirable points about a universal lathe chuck are, that it shall have accurate centering and shall correctly centre the work held; that its grip shall be firm with all sizes and shapes placed therein; that it shall permit a wide range of diameter and shape in the work held, shall be exempt from damage resulting from strain or bruising, shall be quick and easy of adjustment, and not liable to damage from dirt or chips (which also consume time in their removal). It is generally an advantage to have the wearing parts hard, few in number, and readily replaceable when worn. The time lost in changing chucks on miscellaneous job-work forms no inconsiderable item in the cost account; and that in rechucking work, in cleaning and repairing chucks, and in replacing work improperly done on account of faulty chucking, counts up fast on the wrong side of the profit-and-loss page of the ledger.

In the cuts herewith annexed is shown the construction of the Johnson Universal Chuck,* an excellent device possessing in a high degree the elements of durability, firmness, and adaptation to variety of work.

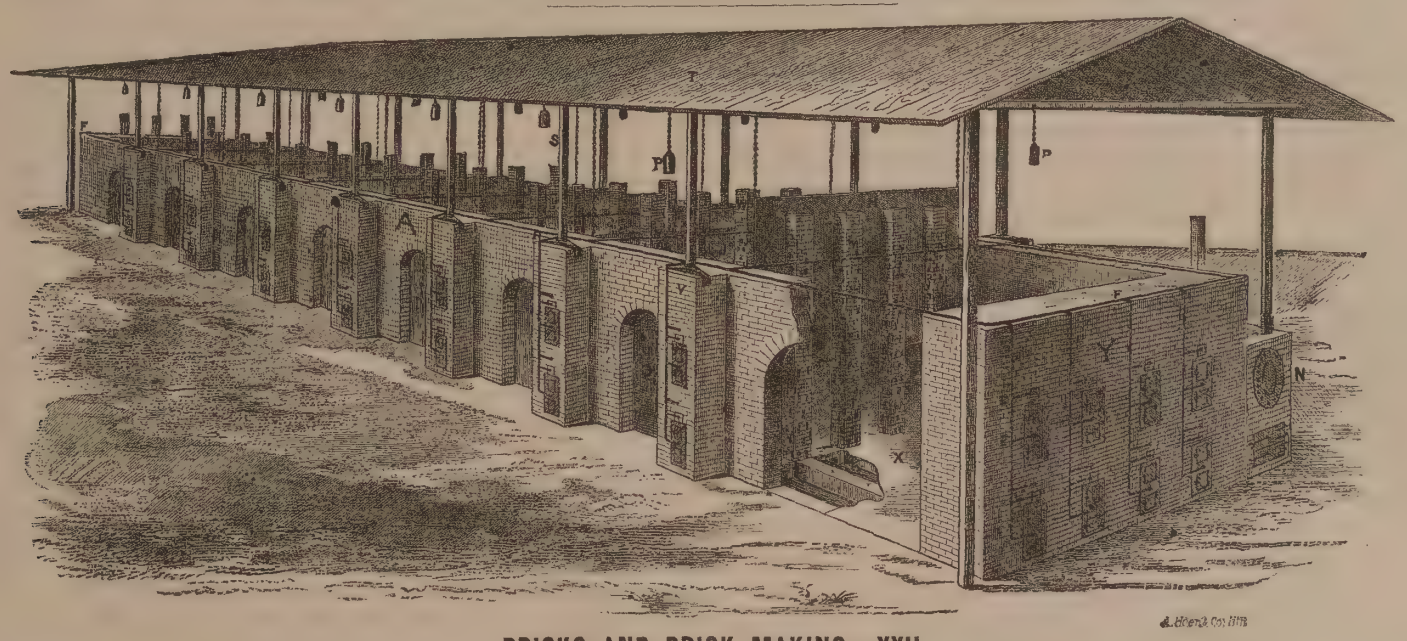
Fig. 1 is a face view of the chuck ready for use. Fig. 2 shows a back view with the back plate removed. In Fig. 3 one of the jaws, *E*, revolves upon a steel pin in the arm of the wheel *B*, to which it is also tongued and grooved, but which, when turned to a certain position, can at will be removed therefrom. The toothed ring *C* has a solid feather (see Fig. 4), and is accurately fitted and forced to its seat upon *B*, which last is secured in place by the screw and plate *D* (Fig. 5).

The toothed rings are rotated by a cast-steel worm-shaft, *S*; and the rings and jaws are of case-hardened hammered iron. The wrench *P* is well fitted and hardened so as to reduce wear. A small screw inserted in the chuck-face prevents the wheels running out unintentionally; there is a screw closing the oil-hole in the edge of the chuck.

As the wheels revolve the jaws adjust themselves to the work, and can be reversed or turned to any position at will, giving great range of work. One peculiar point is that it will hold from the smallest drill to a piece of work of the full capacity of the chuck, *with a pressure increasing with the diameter of the work held.*

G.

*Made by the Lambertville Iron Works, Lambertville, N. J.



BRICKS AND BRICK MAKING.—XXII.

The following is a design for a kiln, by Mr. S. M. Hamilton of Baltimore:

A represents the side of the kiln, and Y represents the front end. It is divided into 8 sections, each 10 feet in length; the walls are 10 feet high, 13 inches thick, and at the front end and sides are two rows of furnaces, placed one above the other. These furnaces, B, are four feet long, and open directly into the combustion chambers of the kiln. C represents the ash-pits, D and E steam pipes injecting jets of steam into the furnaces over and under the fires, for the purpose of discharging the hot products of combustion uniformly into the kiln. With tight doors the under steam jets are sufficient. F and F are main steam pipes, conveying steam from the boiler, N, and supplying the branch pipes. G represents chimneys nine inches square, inside measurement, and about five feet in height above the kiln, used for drawing off water-smoke. A steam pipe, M, enters each chimney at a point five feet from the top, the pipe is bent upwards, in the chimney, and shoots a jet of steam in the same direction, for the purpose of making a draught for drawing off water-smoke, (through holes in front and side of chimneys, as shown in the engraving,) and compelling the hot products of combustion to pass through the bricks from section to section throughout the whole kin.

The kiln is set in the usual manner. The top is made air-tight by laying flat one course of burned bricks, and on this spreading clay or sand, which seals all the joints. When the first section is thus prepared, the fires are lighted in the furnaces at the front end of kiln. Steam is admitted through the jets D and E, over and under said fires, and also into the chimneys (belonging to said section) so as to produce a draught to draw off water-smoke, &c. The section will now be in full blast; the steam-jets blowing over and under the fires, produce a powerful draught, thereby causing perfect combustion of fuel, forcing into the kiln the heated gases, which, becoming superheated from the heat in the furnaces, diffuse the heat through the interstices from front to rear of section. The front is thus prevented from overburning, and the excess of heat is moved onward into the less heated part of the section. This process goes steadily on until the water-smoke is off first section. The iron plate, H, is then raised up, the steam jets in chimneys of first section turned off, the tops of said chimneys closed by an iron plate or tile, and those of chimneys, W, in second section opened, which causes not only heat from the furnaces, but the surplus heat of first section to pass through the bricks into second section, and there utilized in carrying of water-smoke, &c. When that is effected, the next iron plate, J, is raised up, steam jets in chimneys of next section turned on, &c. When the water-smoke is off the fourth section, the cross-fires in second section are started, the bricks in first section settled, and the furnaces at front end closed, the surplus heat from settled section passes into the following sections, and so on. By the time the water-smoke is off sixth section, the bricks in first section will be cooled and discharged; this section is then again recharged with green brick, thereafter the kiln is receiving and discharging daily. The surplus heat from the last section passes through the perforated wall of draught chamber, which forms rear end of kiln, and thence through passages, K, at bottom of kiln, and up vertical passages formed between the furnaces at front end of kiln, thence through holes in said vertical passages, similar in form to those in chimneys, G. The steam jets in chimneys, G, are then turned on, and thus draw the heat through, and the water-smoke off, the green bricks in said section. The aforementioned process is then repeated, thus making the kiln perpetual in its working, leaving three or four sections at all times for charging and discharging bricks. It takes an average of about twenty-four hours to burn each section.

O represents the doors for charging and discharging.

P represents the weights and chains for raising the plate, H; the chains pass over pulleys in beam, supporting shed, T. The weights make it easy to raise and lower the plates.

R is an iron clip for fixing the upright post S on projection V.

V represents the projections in which are the side fires; these projections also serve to strengthen the main walls of the kiln, hence said walls are not required to be so thick as in the old form of kiln.

X represents the bottom or floor of kiln, formed of one layer of bricks laid flat.

A simple steam boiler, 15 or 20 horse-power, for the generation of steam, under a pressure from 50 to 60 pounds, is required.

In the engraving, a part of the side wall of first section has been removed, in order to show the interior of the kiln.

G.

(To be continued.)

DROP FORGING.

The superiority of wrought metal over cast, for all purposes where tensile strength is needed, has long been conceded in practice. Of course, where mere resistance to compression is required, castings have the preference; as while wrought iron and steel have tensile strength respectively 3½ and 3 times greater than the same metals cast, cast iron has three times the resistance to compression, of wrought iron; and cast steel resists crushing two times as well as wrought.§ (To simplify matters, we will consider iron only and not steel, for a time at least.) But there are numerous parts, particularly working parts, in machine and other design, where we wish tensile strength combined with regularity of form, accuracy of size and good finish. Castings, which may be used when great tensile strength, small size and light weight are not imperatively demanded, give the finish and size well enough for large masses; but their roughness and the difficulty of properly allowing for shrinkage make the question of giving finish and dimension a difficult one to answer satisfactorily; and they must be made somewhat too large, and be worked down by grindstone, emery wheel or file, cutting off the hard outer skin* at an expense to the manufacturer, and with detriment to the casting. Furthermore, there are apt to be hidden flaws in the castings. Of course, with castings, we cannot gain all three of the points of great tensile strength, small size and light weight, and must sacrifice one or two of the three. To gain all three of these last points, we take refuge in ordinary forging,—an expensive operation, requiring especial skill and subsequent hand or machine, finishing to dimension. Furthermore, there are many shapes almost impossible to hammer out satisfactorily, and some that could not be done at all. To endeavor to produce the effect of wrought iron by the process of casting, toughened cast iron, having from ¼ to ½ of wrought iron scrap, melted with the cast iron, is used;† but that gives us only a little more nearly the three points of strength, size and lightness, and still leaves on our hands the finishing difficulty and the flaws.

We may still further improve upon this, or "toughened," cast iron, by a more expensive process:—that of rendering our castings malleable by bedding them in red oxide of iron, and heating them to a bright red heat for some days;‡ the effect being that the oxygen of the hematite absorbs some of the carbon of the cast iron, and makes of the metal a kind of soft steel, having three times the tenacity of the original casting; but the product is still a casting, and is apt to have been warped and twisted in the heating. For certain shapes this last may be remedied by straightening, but some shapes (as, for instance, sewing machine shuttles and the female-half of plyers, or a "double-eye"), are beyond straightening; and even if these shuttles and any number of other working parts of machinery were true as a die in size and shape, they have not any where near working-surfaces.

Money-coiners early had this difficulty, and whereas they formerly *cast* coins (as the Chinese still do largely), they afterwards learned to take a blank planchet of approximate shape and size, and to give it the outline and finish by driving the cold material into the fine lines of carefully-cut dies. Spoons, forks, &c., are struck out in the same way. The ingot metal has been toughened and rendered homogeneous by repeated rolling, and the results are highly satisfactory for the purposes named. Of course, in working with cold metal, there is a limit to the amount of relief and of ununiformity of shape attainable by die work, and we find the coin metals much softer and more easily coined or struck up than iron; but by heating the iron, we give its particles mobility and viscosity, and (unless the mass be too large) under a suitable blow they find the lines of the dies, and hold the shape impressed upon them.

The Hull & Belden Company of Danbury, Conn., has for some time made a specialty of drop forging work, which receives new applications each day. The greater sharpness, density and toughness of the drop forging are peculiarly desirable. G.

SULPHUR AND ITS USES.

By Prof. George A. König.

IV.

Manufacture of Sulphur from the Ores.—Available for the direct production of sulphur are native sulphur ores and pyrite. The sulphur deposits of Sicily furnish four grades of ore, obtained by hand-picking: very rich ores, with 25 per cent. of sulphur; rich ores, with 20 per cent.; good ores, with 15 per cent.; poor ores, with from 8 to 3 per cent. They are mixtures of native sulphur with volcanic ashes, *i. e.*, pulverized pumice stone and similar rocks. The properties of sulphur (Part III.) indicate the proper methods of extraction: by *melting* and by *sublimation*. Generally, that method is always the best which produces the poorest residues; but this is not usually the most economical one. However, this is a question which cannot be treated in abstract; local conditions, incapable of generalization, form too important a part. In applying science, the intelligent engineer will select among the theoretically correct methods the one most conformable with local requirements. Extraction of the sulphur by solution would furnish the highest percentage of the substance; the residues could be exhausted completely, but it is quite impracticable from the peculiarities of the solvent carbon disulphide. This compound is expensive and very dangerous through its inflammability. It is so readily volatile at the temperature of the air (particularly in southern climates) that it cannot be handled without loss except in thoroughly closed vessels. Now we could perfectly well construct a plant comprising an extractor, a still in which the solvent would be expelled by heat, and a condensing apparatus for the vaporized bisulphide. We could connect all parts in such a manner that loss of bisulphide of carbon would be avoided; but it is also clear that a plant of this construction, capable of producing say 300,000 tons of sulphur per annum, would require the investment of a very large capital, and would necessarily involve the employment of careful and skilled workmen. Sulphur might thus be extracted completely from the Sicily ores and those similarly composed; yet it is questionable whether the process could compete, under the most favorable conditions, with either the smelting or the sublimation methods now in use. We are not aware that an attempt has ever been made to realize the extraction by solution; and since the pyrites were brought up in very formidable opposition to the native sulphur, it is not probable that such attempt will ever be made. We thought it well, however, to point out the feasibility of this mode of extracting sulphur, to illustrate our point that the possibly best is not necessarily the most economical.

Extracting sulphur by fusion is the method most generally employed in Italy and elsewhere. As now practiced the process resembles considerably the one followed in charcoal-making. An excavation is made into the earth, with a bottom inclined towards the front or working side of the heap. A cover of sand and plaster makes the bottom impervious. A wall three feet high is then erected in front, with a tap-hole at the bottom. The building of the ore-heap is now proceeded with against a rough grate of iron bars, leaning towards the front wall at an angle of 45°. Thus the ore does not come in contact with the wall, the triangular space between the latter and the grate being destined to receive the molten sulphur. The lower part of the heap is made up of the large pieces of the ore, to render it more porous. Having reached a height level with the top of the front wall, a number of small stacks are now erected with pieces of ore, from six to ten, according to the size of the heaps. Around and between the flues the heap is now completed with ore decreasing in size, and allowing a sufficient slope to insure stability of the structure. A solid and tight covering of clay and broken residue from former operations is finally placed upon the heap. The dimensions vary considerably—from 3000 to 30,000 cubic feet, and a height above the top of the front wall of from nine to twelve feet. It is clear that the heat required for the fusion of the sulphur must be generated by the combustion of a part of the latter. By throwing ignited bundles of grass dipped into molten sulphur down the shafts, the ignition is effected, and after twelve hours the shafts are covered with stone plates and wet slag; the tap-hole is closed. The sulphur flows freely after twenty-five days, and stops flowing in about two months from the starting day; it is run into moist wooden moulds, and the blocks weigh about 130 lbs. The yield does not go above 80 per cent. of the sulphur contained in the ore, and is usually not more than 75 per cent. The cost of production per ton of 2000 lbs., including transportation to the port of Palermo, is stated by good authority to be from $11 to $14.50, according to the yield of the ore. In Italy these heaps are called "*calcaroni*," whilst the low kilns in use formerly, yielding a much lower percentage and poisoning the vegetation for miles with sulphur dioxide, were called "*calcarelle*." The success of the operation with the calcaroni depends entirely on the care with which any air is kept out of the heaps beyond the quantity actually required to generate the *necessary* heat. The largest loss comes from the sulphur retained in the residue. We know that above 150° C. the sulphur becomes viscous, loses its fluidity, and consequently will in part at least stay in the earthy parts. The temperature should not rise above 115° C. This can never be realized in a calcaroni or any other contrivance with direct heat. The latest proposition, some four years since, was based upon this fact, and treats the ore in vertical iron cylinders, with superheated steam—a very excellent plan. Works were erected on this plan, but whether found to be less economical than the calcaroni in the long run, or from other reasons, the process does not seem to have met with general acceptance; no communication has been made about it in the literature since. Again must it be said, no new process whatsoever should be put in operation in a new locality, and calculations of superior veritability built upon it, until it has been thoroughly tested by competent engineers familiar with the features of actually employed methods. The great number of commercial failures of manufacturing companies is directly traceable to the starting with a new and comparatively untried process.

Extraction of Sulphur by Distillation or Sublimation.—We have seen that sulphur boils at 440° C., passing off in brown vapors, when air is excluded. Requiring a much higher temperature than the previous method, and consequently either a considerable loss by burning sulphur or other fuel for heating the retorts, it is clear that this method can only compete with the former under exceptional conditions, or when the sulphur is desired in the form of flowers. For poor ores (3 to 8 per cent.), with cheap fuel and low wages, sublimation may be employed. The retorts in use are uniformly of iron, as cylinders or kettles; cylinders are preferable. At Marseilles, Sicilian raw sulphur is converted into flowers in horizontal iron cylinders five feet long by twenty inches in diameter. The cylinders are closed at the front end, and bolted to an ascending iron flue of equal diameter at the other end. This flue leads into a walled chamber twenty-four feet long, twelve feet deep, and fifteen feet high. The chamber is well lined with cement and perfectly air-tight. Two retorts connect with one chamber. An iron kettle, three feet in diameter by three feet deep, placed above and between the retorts, receives the raw sulphur (about 1600 lbs.). The fire-gases, after heating the retorts, are made to circulate around the kettle, causing the sulphur in it to melt, which is then run into the retorts by a connecting-pipe. Two distillations in twenty-four hours, 300 lbs. each, produce flowers. But if the apparatus is worked continuously at its full capacity—that is, 3600 lbs. in twenty-four hours—then the sulphur results molten, and is cast into conical wooden tubes, closed with a wooden plug. The reason for this difference lies in the rising of the temperature in the condensing chamber above 112° C., where the furnace works continuously.

A lenticular-shaped retort, as used at Anvers in Belgium, is said to work more economically—and ought to, having a larger surface for the same cubic contents than a cylinder, and hence absorbs the heat of the fire-gases more readily.

Pyrite contains two atoms of sulphur to one of iron. It loses one atom of sulphur when heated to near red heat. Formerly this property was made use of to obtain sulphur, by carefully conducting the roasting process in kilns and open heaps. Since, however, all the larger smelting works make also sulphuric acid, it is more remunerative to burn all the sulphur to sulphur dioxide. Pyrite is no longer used for the production of sulphur.

Flowers of sulphur are often made impure by the presence of sulphur dioxide, of sulphuric acid, and also arsenic sulphide. Of the first two a simple washing with water will effect purification. Arsenic is much more difficult to remove; in fact it is impossible to do so completely. The percentage may be narrowed down more and

§ Of course these figures are approximations.

* The cause of this skin is the chilling or cooling of the outer layer more quickly than the interior, and its approach more nearly to the condition of granular white iron, commonly called "chilled iron.',

† This plan was invented by Mr. Morries Sterling.

‡ Say twenty-four hours to heat up; three to five days at the red heat, according to the size of the casting; twenty-four hours to cool.

more by careful resublimation; but a product chemically pure and medicinally quite satisfactory can only be prepared, in a roundabout way, by decomposing artificial or natural sulphurets. This brings us to one of the most interesting chapters in the technology of sulphur: the utilization of the residue from the soda-ash process and the working up of the "foul lime."

(*To be continued.*)

THE BEET ROOT SUCAR INDUSTRY.

By LEA PUSEY.

II.

ROTATION OF CROPS—FERTILIZERS—ANALYSIS OF THE BEET.

The crops grown alternating with each other are usually wheat, beets, oats, rye, and barley; every three or four years the land is well covered with barn-yard manure, sometimes for the wheat crop, as is done here; others prefer manuring for the beet, which is invariably done in the previous fall soon after the wheat is harvested. In addition to the barn-yard manure, increased profit is obtained by the judicious application of fertilizers, increasing both the quantity of beets and the percentage of sugar in the juice. Extensive and careful experiments have been made with phosphates, guanos, mixed and separate, also other compounds, resulting as follows: one part Peruvian guano, and two parts Gussefeld's super-phosphate, increased the crop of beets, also increased the percentage of sugar from 12.49 per cent. to 13.62 per cent. The super-phosphate was composed of phosphoric acid, 19.9 per cent.; magnesia and lime 17.3 per cent.; sulphate of lime, 42.1 per cent.; moisture, &c., 20.7 per cent.

In seventeen cases recorded in Saxony, fields manured with two parts Peruvian guano, and three parts phosphates, increased the crops 3 1-2 tons per acre. A fertilizer composed of 20 per cent. of sulphate of potash, 20 per cent. sulphate of magnesia, 40 per cent. common salt, and 20 per cent. of other substances, applied at the rate of 1 cwt. to the acre, increased the yield of beets, and the percentage of sugar was increased from 13.23 per cent. to 14.95 per cent. A larger application produced no further benefit. These results indicate that an entirely well established mode of profitably applying fertilizers, to even so common an article as the sugar beet, has not yet been arrived at. Science informs us that one ton of beet-root contains 16.11 pounds of ashes, composed of the following ingredients: potash, 4.99; soda, 3·02; lime, ·41; magnesia, ·43; oxide of iron, ·12; phosphoric acid, ·66; sulphuric acid, ·65; chloride of soda, 5.29; silica, .54. These figures may furnish data by which to determine the most suitable fertilizers to try. Common sense would dictate that profitable results would be more certain, if careful records were made of such trials, as a guide by which to determine the best application of expensive and ofttimes profitless fertilizers. After all, the universal experience shows that the main, reliable, and certain manure is made in the barn-yard. Increase the quantity and quality; keeping it under shelter will improve it and at the same time make it lighter for hauling. This is the chief fertilizer for the beet crops of Europe, and cannot be neglected here without loss.

COMPARISON OF THE BEET SUGAR OF EUROPE WITH THE CANE SUGAR OF THE TROPICS—PRODUCTION PER ACRE, PER HAND—RELATIVE INCREASE.

Chemical analysis confirms the most critical tastes, that the refined beet sugar is identical with the refined cane sugar; that question settled, the next in order would be, which can be produced at the least cost of capital and labor? As has already been stated, owing to the length of the season for manufacturing beet sugar, as compared with that of the cane, about one-third of the capital is required for buildings and machinery, for the same amount of product. The product of cane sugar per acre, in Cuba, averages 1,709 pounds; in Martinique, 1,587 pounds; in Porto Rico, 3.950 pounds; in Louisiana, 1,100 pounds. The product of beet sugar per acre in France averages 2,200 pounds; in Germany, 2,100 pounds. The amount of cane sugar produced per hand upon some of the best ordered estates in Cuba is 4,400 pounds, on a few, 6,400 pounds to 7,000 pounds, and on one the large amount of 13,327 pounds. In France and Germany the product of beet sugar exceeds 14,000 pounds per hand.

In 1853 the total product of cane sugar was 1,278,300 tons, of beet sugar, 200,000 tons; total, 1,488,300 tons; the beet sugar being less than one-seventh. In 1873 the product of cane sugar had increased to 1,812,000 tons, and the beet sugar to 1,143,000 tons; total 2,955,000, of which the beet was nearly three-sevenths. Another decade and the beet sugar will have passed the cane, if this rapid increase continues, notwithstanding the latter has taken advantage of and adopted the many valuable improvements made by the beet sugar manufacturers in the perfecting and cheapening of its processes.

SOME REASONS WHY THIS INDUSTRY HAS NOT BEEN INTRODUCED INTO THIS COUNTRY—THE STRONG PROBABILITY OF THE CLIMATE AND SOIL SUITING THE BEET—TRIALS, SUCCESSES, AND FAILURE—LAWS FAVORING IT—COST IN FRANCE—ESTIMATED COST HERE—SUGGESTION HOW TO DO IT.

The interested reader will naturally wonder, if these things be true, how is it that so little is known, or so little done in this country, a country so full of publications devoted to science, agriculture, and indeed to all subjects tending to improvement or profit. The very fact of this absence is against it.

A careful investigation of the circumstances will indicate, if not establish, the sufficient reason. Previous to 1860 about one-third of the consumption was produced in Louisiana; since the war the consumption has largely increased, and the Louisiana production has not yet recovered from that disaster. It now produces only about one-fourteenth. In the same period, from 1860 to 1876, there have been valuable improvements made, reducing the cost of producing the beet sugar; these are some of the principal ones; therefore it will be a matter of greater wonder, if in a few years we do not follow other nations of the Temperate Zone, and adopt this industry, now so well perfected to our hand.

The experience of Europe shows that beets of rich quality can be profitably cultivated on suitable soil, from the Mediterranean to the North sea, and from the Atlantic to the heart of Russia. Moisture favors the development of the beet, and drouth does not prevent its yielding good products. The universal testimony of farmers and sugar manufacturers is, that any good wheat land is suitable for the sugar beet. It is almost identical with the mangel-wurtzel, the cultivation of which for stock has been very extensively and successfully practiced in the Northern, Middle, and Western States.

Several attempts have been made to introduce it in some of the Western States and California. The former have failed; the latter are at length successful in that wonderful climate, after two or three years struggling. The reasons for the failure of the former were many and sufficient. To recount their history would add length without value to this paper. The lesson taught by it is also renewed in the low average results of the experiment of this year. Ordinary cultivation would be wasted on the sugar beet. The whole question turns on first ascertaining, by an actual test, the best soil, located where cheap fuel, lime, good water, and labor can be had; these indispensable prerequisites secured, a successful result is sure, with ordinary business management.

The total cost, allowing interest and everything, except the tax (about 2 1-2 cents per pound), of producing beet sugar in France is from 3 1-2 to 4 cents per pound. This pays $3.25 per ton for the beets, and 1-2 cent per pound for labor in the factory, at an average of 66 cents per hand per day. From these data it is fair to infer that beet sugar could be produced here at a cost not exceeding 6 cents per pound. The present market value of sugar is from 9 to 12 cents per pound, according to grade.

In 1867, by joint resolution of Congress, the duties on beet sugar machinery, imported solely for manufacturing, were removed. In 1872 New Jersey enacted a law exempting beet sugar factories from taxation for ten years. Yet with these inducements offered for several years, and plenty of idle capital, none has been invested in this industry, either in New Jersey or contiguous States. The inference is, that before capital, unaided, will venture into this untried field, it must be plainly demonstrated that the investment will be quite certain to pay. The most feasible way to effect this result is to establish a moderate sized enterprise, which will embrace the production of the beet on suitable soil, the adoption of methods of cultivation which will insure an average of 12 per cent. of sugar, and then extracting a merchantable article in sufficient quantity to pay. In other words, import a French or German sugar factory complete.

The capital for such an enterprise can come only from uniting the interests to be benefited by its success; State aid, or patriotic capitalists, or a combination of all of these. The sooner this can be effected the better.

Canada, recognizing its importance, has offered $7000 per annum, and exemption from taxation for ten years, to the first beet sugar manufactory established in the Dominion.

(*To be continued.*)

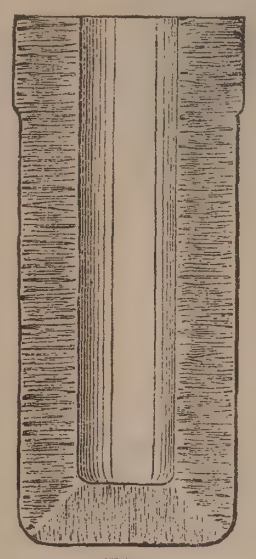


Fig. 1.

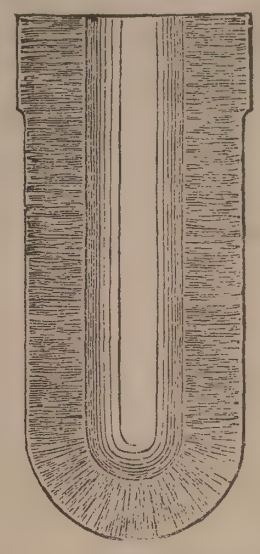


Fig. 2.

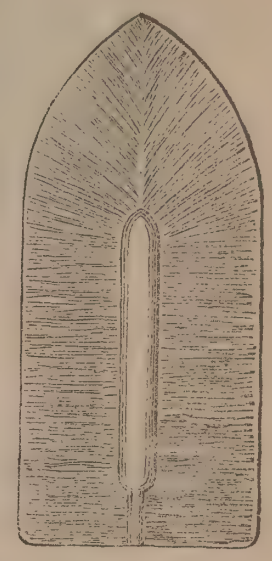


Fig. 3.

THE COOLING OF CASTINGS.

Such an interesting discussion was awakened by the publication of Mr. Trautwine's article on the thickness of cast-iron cylinders to resist internal pressure*, that a few remarks on a frequent cause of fracture of such cylinders may not be out of place, even after the very interesting communications of Messrs. Haines, Couch, Haug, and Schleicher.

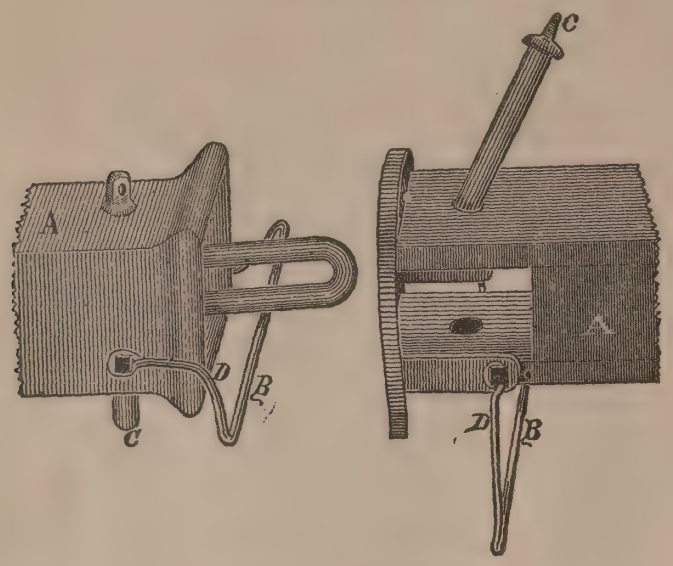
The design in casting either guns or hydraulic cylinders is to have the metal so disposed that under pressure each part shall be promptly and equally ready to bear its load, and that there shall be no weakest part, no predisposition to give way in a special or unexpected direction. The plan of hooped structures accomplishes the result where casting is not a necessary process, each successive lamina having put upon it by shrinkage a stress proportioned to its nearness to the interior. Where casting is necessary in gun-making, a water-core cools the metal from the bore. If the tube (our idea of a hollow cylinder proper is the *bore* of a tube) is cooled from without, as in the common mould, the inner and last-cooled portion will be in less tension than the outer, which is the very reverse of what is desired. But where a water-core cools the interior, and a fire is kept around the exterior of the mould, the outside laminæ cool last, and grip the interior or already cold layers, giving them the greatest tension, which is what is needed and desired.

But the special point to which we wished to call attention is the predetermination to fracture at certain points caused by certain conditions in cooling. We must remember that when castings cool, the crystals are arranged in lines perpendicular to the cooling surfaces of the mould. A chilled casting shows this plainly enough; and any ordinary casting is simply a less exaggerated type of the same thing. It is, then, obvious that a trunnion or fillet on a cannon, or an acute angle or a sharp projection, may introduce elements of discord into the crystallization and predetermine the fracture at a certain point. The hydraulic cylinders for raising the "engineering monstrosity" referred to in the articles mentioned were made with a flat bottom, as shown in section in Fig. 1. In cooling, the crystals ranged themselves perpendicularly to the outer surfaces, and thus those in the cylindrical portion were radial and those in the flat bottom were axial; and the lines of weakness were as shown in the lines drawn from the inner to the outer corners in the section, Fig. 1. The cylinder failed at this line, although thicker there than elsewhere. If the inner angle had not been slightly rounded off, the tendency to start the fracture would have been greater; had the junction of sides and bottom been less abrupt, the predisposition to start the crack would have been less, although once started the lines of weakness shown would have been the lines of fracture. The substitute cylinder was made as shown in section in Fig. 2, where all the lines of crystallization are radial and more nearly parallel; and the same amount of metal produced a stronger cylinder, both on account of the absence of sharp interior angles to start a crack, and of sharp exterior angles to cause faulty arrangement of the crystals. Hummel, of Berlin, makes his cylinders with a separate bottom, and they work very satisfactorily under the heaviest pressures. The packing of the joint is effected by simple angle-rings of leather. In casting iron cannon, the "soda-water bottle" style is chosen as avoiding any exterior fillets, &c., the curved surface permitting the escape of the heat in a nearly uniform current in every direction, in lines radial from the centre of explosion.

Apropos of guns, a curious phenomenon observed in the section of chilled shells is the curved lines of the crystals, as shown in Fig. 3, which apparently contradicts, or at least cannot be at first accounted for by, the law of radiation and crystal-forming referred to. The lines are nearly straight in the body of the casting, but are curved in the point! The phenomenon is explained in this way: the shell is cast *point down-*

* See this journal, last volume, pages 220, 247, 271, and 278, and also page 24 of current volume.

wards, and as it shrank, while forming an exterior crust, it settled in the mould, resting on the point, which became a point of contact competing in the abstraction of heat with the sides of the mould, which the casting did not actually touch. Such shells may be seen in Memorial Hall, in the collections of the Pennsylvania Museum and School of Industrial Art. G.



NEW CAR COUPLING.

"The object is to so improve the common draw-heads that the link may be readily and conveniently guided to the opposite draw-head by the brakeman without danger of injury to the hand, so that thereby accidents, trouble and expense may be avoided. The invention consists of a draw-head with a swing-bar, pivoted to screw-pins at both sides, near the lower part of the same. The swing-bar is bent of one piece of rod iron, with side extensions. *A* represents a draw-bar of the well-known form that is coupled with the common pin and link. A swing-bar, *B*, is hung by rearwardly-extending arms, *D*, to the ends of pivot-pins, *C*, at both sides, and at the lower part of the draw-head. The swing-bar *B* drops vertically below the pivot-pins when not in use, and may be readily carried up into horizontal or inclined position by the side extensions of the same, which admit the ready handling of the swing-bar and the holding of the link from both sides into proper position for coupling. The swing-bar *B* is bent of one piece of suitable rod-iron, its lower straight part being made of sufficient width to form the side extensions, the upper parts or arms, *D*, being bent or doubled back on the lower part, and then in upward direction to the cross-pins, to which the ends are hung by eyes and retained by the heads and washers of the screw-pins *C*. The swing-bar should be applied with little expense to any draw-head, and admits the raising and guiding of the link for coupling, if desired. The pendent position of the swing-bar, when the cars are coupled, should prevent damage to the same, as it is entirely out of the way.

The inventor claims that the link-guides now known are apt to be broken by the concussion of two draw-heads, and are not as simple in construction as this, which, when not in use, is entirely out of the way and not exposed to danger. This link-guide can also be applied to ordinary draw-heads with ease, as it is held in place only by removable pivot screws or studs at the sides of the draw-heads."

[Patented January 9th, 1877, by Hermann Wittmann, of Manitowoc, Wis.]

ADEE'S SEWER TRAP.—We wish to add to the notice of Adee's Sewer Trap, which appeared in our last issue, a claim made, and pointed out to us, by the inventor, namely: that the heavy body of water contained in the trap prevents syphonage, because the weight of water is so great that it is easier to draw air through it than it is to lift the water; consequently, when there is a suction created in the soil pipe, instead of emptying the trap, air is drawn downward through it, leaving the water seal undisturbed. We are about subjecting one of these traps to practical test, and shall take pleasure in reporting the result of the same in some subsequent issue.

[Copyright applied for.]

SLIDE VALVE GEARS.

By HUGO BILGRAM.

II.—THE COMMON SLIDE VALVE.

The usual form of the common slide valve is shown in Fig. 1, where *S* and *S'* represent the steam passages of the cylinder,

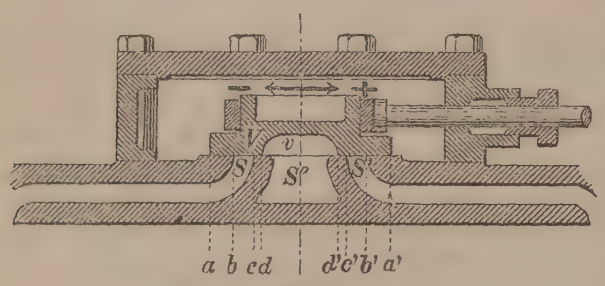


Fig. 1.

and *S°* the exhaust passage. *V* is the valve, the cavity *v* of which effects alternately a connection of the steam ports with the exhaust port. The valve is encased in the steam chest, into which the live steam is admitted. It is moved by the valve stem passing through a stuffing box of the steam chest.

When the valve is in its neutral position, as shown, its face overlaps the steam ports on both sides. The distance *a b* is called the outside or steam side lap, and *c d* is the inside or exhaust side lap.

In the following considerations we shall term "positive" any movement of the valve from its neutral position towards the valve stem, in contradistinction from a movement in the opposite or "negative" direction. A positive movement of the valve connects the port *S'* with the exhaust passage *S°* through the cavity *v*, and opens the port *S* for admission of steam from the steam chest. The width of the opening of either port depends on the distance of the valve from its neutral position, for the time being. This distance, or the "movement" of the valve, must exceed the inside lap before the port *S'* will be opened for exhaust; and it must be greater than the outside lap, to effect an opening of the port *S* for admission of live steam. For a given movement of the valve we find the opening of the steam ports for either exhaust or admission by deducting from this movement the inside or outside lap respectively. When this difference is equal to or greater than the width of the port, the latter is fully opened. The effect produced by a motion of the valve in the opposite negative direction is similar, but reversed as regards the pas ages *S* and *S'*.

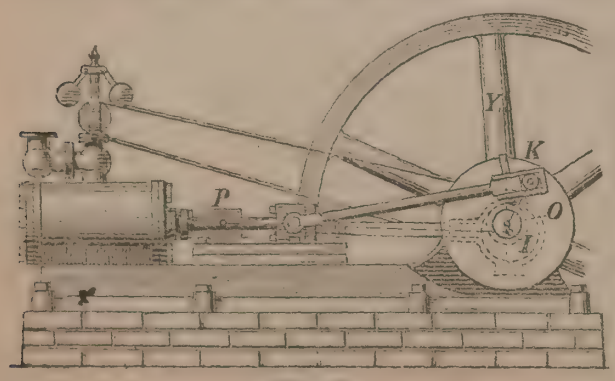


Fig. 2.

The valve is moved through the eccentric *I*, (Fig. 2), which can properly be considered as a small crank, the pin of which is enlarged so much as to assume the form of a disc that allows the shaft *O* to pass through it. The eccentric can therefore be represented by the line *OI*, that connects the centre of the shaft, O, with the centre of the eccentric disc, *I*, and which is supposed to act like a crank.

THE VALVE DIAGRAM.

We shall first consider horizontal engines of the usual construction, in which both the connecting rod and the eccentric rod, are operated in parallel directions.

The eccentric of such engines is keyed to the crank shaft so that the centre line *OI* (Fig. 2) of the eccentric forms an obtuse angle with the centre line *OK* of the crank. As the crank shaft rotates, the end *P* of the eccentric rod, being guided in a right line by the valve stem, receives a reciprocating motion while the rod itself is caused to oscillate. The reciprocating motion of the end *P* is transmitted through the valve stem to the slide valve. The oscillating movement introduces a very intricate factor, since it affects the horizontal extension of the eccentric rod. We shall, however, at present leave this factor altogether out of account, and shall examine it later.

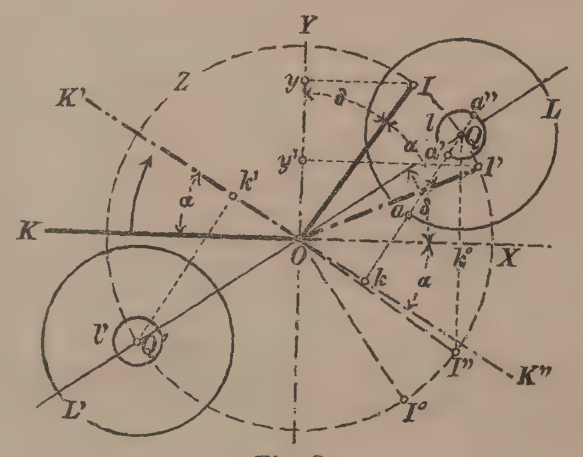


Fig. 3.

It is necessary to locate the centre of vibration of the end *P* of the eccentric rod on account of its corresponding relation to the neutral position of the valve. The vibration of this point being a direct result of the circular movement of the other end, *I*, of the eccentric rod, it is evident that the centres of both movements must correspond. Therefore, if the end *I* of the rod *IP* be transposed to the centre of its motion, (which is the centre *O* of the crank shaft) its other end *P* will occupy the centre of its vibration. It will now be understood that the movement of the pin *P* depends on the horizontal movement of the centre, *I*, of the eccentric; and can therefore be measured by the horizontal distance of the point *I* from the vertical centre line *O Y*.

When the crank is on its centre *OK* (Fig. 3) and *I* is the corresponding position of the eccentric, the distance *I y* will represent the valve movement.

As the crank moves from *K* to *K'* through the angle *a*, the eccentric will move through the same angle to *I'*, and *I' y'* will now be the distance of the valve from its neutral position.

Let us now mark the point *Q* in the circle *Z* representing the orbit of the eccentric; making the angle *XOQ* equal to the angle *IO Y* (both of which are marked *δ* in Fig. 3), and draw the line *Q k* perpendicular to the extension of the line *OK'* of the crank. The triangles *QOk* and *I' Oy'* will then be equal, since the angles *QOk* and *Q kO* are equal respectively to the angles *I' Oy'* and *I' y' O*, and the side *OQ* equals the side *OI'*; hence the line *Qk* equals *I' y'* and therefore is equal to the movement of the valve for the crank angle *a*. The same relation can be shown, in the same manner, for any other crank angle, and the interesting fact is thereby demonstrated that, *for any angle of the crank, the distance of the point Q from the centre line of the crank is equal to the corresponding movement of the slide valve.*

To find the openings of the ports for either admission or exhaust, the inside or outside lap is to be deducted from this movement. This subtraction can be graphically performed by sweeping two circles, *L* and *l*, from *Q* with radii equal to the outside and inside laps, as shown in Fig. 3. For the considered position, *K'*, of the crank, the movement of the valve was found to equal the distance *Q k*, and hence the opening of the steam port *S* (Fig. 1) for admission of steam is equal to *ka*, and that of the port *S'* for exhaust equal to *ka'*; these distances being equal to the movement *Qk'*, minus the respective laps. The port openings are therefore represented by the shortest distances between the centre line of the crank and the lap circles *L* or *l*, respectively.

Had the point *Q'*, instead of *Q*, been selected, the result would have been the same, since *Q k* equals *Q' k'*.

To prevent any misunderstanding it may be here stated that Fig. 3 now represents two distinct diagrams, one showing the position of the eccentric, *I*, in relation to the crank, *OK*, when on its centre, and another in which the point *Q* figures and which will be called the "valve diagram." The latter can be obtained from the former by making the angle *XOQ* = angle *YOI*, or also, by rotating the first diagram through a right angle, when the eccentric will arrive at *I*," and subsequently inverting it. This last mode of converting one diagram into the other, can very conveniently be performed by means of a piece of tracing paper, viz., by tracing the diagram of crank and eccentric, *KOI*, turning this tracing over and setting the crank line, *OK*, in a vertical position, pointing downwards. The position of the eccentric, *I*, will then locate the point, *Q*, whose mate, *Q'*, is diametrically opposite.

In order to know the direction of the valve-movement we must consider that the valve will be in its natural position when the crank passes through *Q* or *Q'*, the distance of *Q* from the crank-line being zero. As the crank moves from *Q'* through *K'* to *Q*, the movement of the valve is positive, and while moving from *Q* to *Q'* this movement is negative.

When the engine is required to rotate in an opposite direction, the position of the eccentric will be *I°*, in relation to the crank, *OK*; and the valve diagram will be reversed or left-handed.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

Torpedo Experiments.—Some experiments were recently made with a Thornycroft torpedo boat in the Thames, to settle a question that had arisen as to the effect of bullet holes below the water-line. The result is both curious and interesting. A rifle was fired at the sides, so as to make a hole about a foot below the load-line, which was found to admit sufficient water to fill a bucket in 25 seconds. When the vessel was moved ahead the quantity diminished, when a speed of 10 knots an hour was reached the leak was of no particular moment, and when the highest speed, 18 or 19 knots, was attained, little, if any, water found its way through the hole, the boat appearing to draw a skin of water with her, which kept out the body of water beyond the skin.—*Eng. Mech.* xxv, 430.

The Westinghouse Brake in Belgium.—The report of the committee appointed by the Belgian government, after an extensive and protracted trial of a number of continuous railway brakes, and a full investigation of their respective merits, recommended the adoption of the Westinghouse automatic upon all the Belgian state railways. This recommendation was adopted by the Belgian government, and the great life-saving and accident-avoiding invention which originated in this country, and which is now used on the passenger trains of nearly all the important American railways, has thus received an emphatic and conclusive endorsement from a very high foreign authority. Meanwhile the battle of the brakes is continued in England with great zeal, but the Westinghouse brake has received so many marks of approval in that country, and its superiority has been demonstrated on so many occasions, that its adoption by a large number of the English lines is well assured. In Germany a competitive trial of different continuous brakes is about to be made, with a view to the adoption of the one that proves the most useful and reliable on all the state lines.—*Railway World,* iii, 626.

The Mississippi Jetties.—Captain James B. Eads has made a lengthy report to the South Pass Jetty Company, of St. Louis, which covers almost the entire operation at South Pass since the work has begun. The result, as stated by Captain Eads, is as follows: Our works were begun two years ago in an unused outlet of the Mississippi river, and have necessarily disturbed the regimen governing the overflow to the sea by an enormous volume of water; but theories upon which they were based have been fully vindicated by the results produced, and it is now manifest that entire and complete success will reward our labors. Captain Eads, in his report, claims that across the sand bar at the mouth of the pass the channel is 20 feet deep and 200 feet wide, where previously the depth was 8 feet; that over the shoal at the head of the pass the channel is 20 feet deep and 400 feet wide, where previously it was 14 to 15 feet deep; that for 2,000 feet there is a depth of 28 feet and width of 300 feet; that the Gulf current will prevent any bar forming outside the jetties. He says in conclusion: Finally, I may add with absolute certainty that this entire system of works is now so far completed that no financial difficulties can intervene to arrest the processes of nature which are constantly operating to enlarge and perfect the desired channel through them.

Steam Motors on City Passenger Railways.—The president of the Market Street Passenger Railway Co. recently stated to a newspaper interviewer that the Baldwin and Troy dummies can be run to better advantage than horse cars; that the principal objections made to them are by persons who complain of the odor and heat they produce, and that experiments are in progress by which these evils will be probably overcome. The present tracks are also believed to be not as appropriate and advantageous for steam motors as those formed by the New York rail, which has a flange on both sides, and this will probably be adopted gradually, when repairs are required.—*Railway World,* iii, 650.

Union of the Caspian and Black Seas.—The present century has witnessed several remarkable achievements in maritime engineering, such as the drainage of extensive arms of the sea in Holland, the construction of the Suez Canal, and the deepening of the estuary of the Mississippi; and these not being enough, still more gigantic schemes have been projected. It has been proposed to admit the Mediterranean into two extensive tracts of the Sahara, which would give water communication to a large portion of Algeria, and make a sea-port of Timbuctoo. Neither plan is likely to be put speedily into execution; but, in the meantime, Mr. H. T. Spalding, of Bloomfield, N. J., comes to the front with a proposal to turn the waters of the Black Sea into the Caspian, thus enlarging the latter to its pristine size, and turning the barren and almost impassable deserts, left by the subsidence of its waters, into a highway of commerce for Central Asia. This ancient sea basin is considerably depressed below the general ocean level, and has been slited up in the course of ages by the Ural, Volga, and other lesser streams which flow into it. The consequence of this contraction and shallowing of the Caspian has been, not only that the land left dry is incurably barren, but that the surrounding country has become unfruitful from want of rain, consequent on the diminished evaporation. Mr. Spalding proposes, as we have said, to restore to the Caspian its ancient body of waters, its ancient depth and area, which was nearly double its present extent, by connecting it with the Black Sea by a channel 150 miles in length, about 170 yards wide at its eastern extremity, but two-thirds narrower on the western half. The projector calculates that, at the end of forty years from the beginning of the work, the level of the two seas would be so nearly uniform that the navigation of the new channel could begin. Mr. Spalding further proposes to join the Don to the Volga, and thus lay the Sea of Azof also under contribution. The mere excavation of the proposed canal does not seeem very difficult; and as the Russian government appears to have directed its attention to the scheme, doubtless the opinion of competent scientific men as to its feasibility will be obtained. If it should prove successful, it would be a magnificent work, and followed by political and economic results more than commensurate with the skill and outlay that would be required for its completion.—*Harper's Annual Record,* 1876.

Iron Telegraph Poles.—Experiments are being made to determine the applicability and economy of iron telegraph poles on the Berlin-Königs-Wusterhausen line along the Görlizer railroad. The poles are in the form of double T irons, and are placed upon foundations of granite which are built on the earth. The insulators and their supports are fastened to iron cross pieces.—*D. A. Polytech. Ztg.,* v, 309.

Opening of a New Narrow Gauge Road to Atlantic City.—A few days ago a party of some forty excursionists, including the officers and directors of the Philadelphia and Atlantic City Railroad Company, and invited guests, made the first trip over the new road. The excursion was made with a view to inspect the construction, equipment, and terminal facilities of the railway. The party assembled at 12 o'clock at pier No. 8, on Delaware avenue, just above Walnut street, where the steamer Pilot Boy was awaiting them. This steamer has been secured by the company to carry passengers to the depot in Camden, and convenient waiting rooms are prepared for them on this side. After a ten minutes' run down the river, the depot and offices at Bulson street wharf, the Camden terminus of the road were reached. Bulson street wharf is just below Kaighn's Point and directly opposite the old Navy Yard. Here a handsome and convenient depot has been erected, portions of the offices of the Centennial Board of Finances being used for that purpose. The Centennial Bank building also has been removed here and arranged for the business offices of the railway company. Starting from this point, the railway runs for fifty-four miles, by easy grades and curvatures, to the Atlantic City terminus at the corner of Atlantic and Arkansas avenues. Here a depot, similar to the one in Camden, has been erected. The gauge of the road is three feet six inches; the rails are made of Bessemer steel, weighing forty pounds to the linear yard, and the rolling stock and equipment is proportionally light. The cars, built by Bowers, Dure & Co., of Wilmington, Del., are supplied with every convenience for passengers. In winter they will be warmed by the Baker heater. The trains are supplied with air brakes. The engines of the road weigh from ten to twenty-two tons, instead of thirty to thirty-five tons, as is usual on broad guage railways. There will be eight of these, seven built by the Baldwin Company, of this city, when the equipment is complete. In addition to the main line, now completed, it is the intention of the company to construct branch lines to Haddonfield, 1½ miles; to Leed's Point, 10 miles; and to Somers' Point, 7½ miles. It is the intention of the P. and A. C. Company to foster and encourage, by every means in their power, the local traffic of the road, and to run frequent way trains for local travel. The principal stations for the present will be at Hammonton, Elwood, where the station-house is now completed, Egg Harbor, and Pleasantville. At Atlantic City, the handsome and convenient Lafayette restaurant, from the Centennial, has been erected as an excursion house. The excursions began on the 16th of this month, as many as forty having already been arranged. A telegraph line, owned by the railway, is now building by the side of the track, and when completed will greatly facilitate the business of the road.

Trials of Steel Wire Rope hawser have been made recently at Portsmouth Dockyard, with the result of showing that the breaking strain of the steel wire ropes is more than three times that of a hempen hawser. The sizes tested were respectively 7 in, 6 in, and 5½ in. in circumference, and were guaranteed to have a breaking strain of 110 tons. 80 tons, and 67 tons respectively. They broke at 118 tons, 92 tons, and 75 tons, in each case considerably higher than the guaranteed strain, although the ropes actually tested were picked out at random from a number supplied some time since. The core of each rope is formed of tarred hemp, over which are twisted the strands of wire, the strands themselves being made up in some cases of as many as 19 highly-tempered steel wires.—*Eng. Mech.,* xxv. 531.

The Simplon Tunnel.—The preliminary surveys for the cutting of the Simplon Tunnel and the construction of the approaches are in course of execution. The plans were finished in the Bureau of Lausanne. The line commencing at Brigue, and which will serve as an international station at the entrance of the tunnel, has a length of 18,340 metres. The tunnel immerges at Isella, and the line advances from there to Bomo d'Assolla. The total length of the line is estimated at 46,900 metres. Near Bomo it joins the old ways, which continue the Italian lines to the station of Arona. As far as the village of Crevola the line runs along the left bank of the Boveria, but arriving at this point it crosses the river on a large viaduct.—*Annales du Génie Civil,* xvi, 379.

MINING, METALLURGY AND MINERALOGY.

The Siemens Direct Process.—At Towcester, Northamptonshire, England, Dr. Siemens has erected experimental works for the purpose of developing his method of making wrought iron direct from the ore. The works consist of three rotating furnaces, with their producers, a gas-heating furnace, a small steam hammer, and the necessary ore crushers, and boilers and building, and a laboratory. It has been running, only experimentally, from time to time, for two years, and has turned out 600 tons to 700 tons of blooms, which have been sold and worked up.

A charge of about 2000 pounds of ore, of a mixture containing about 55 per cent. iron, and 1¾ per cent. phosphoric acid, is put into the rotator, together with about 100 pounds limestone and 600 pounds bituminous coal. The materials are crushed to the size of large peas and smaller, and are mixed before being put into the furnace.

As soon as the door is closed, the furnace is set revolving at the rate of ten turns per hour; the air from the heated regenerator is put on full, but the gas is slightly admitted, if at all; usually it is shut off entirely. The first operation, which begins at once, is the distillation of hydro-carbons from the coal as it comes in contact with the heated walls and the hot air, there is not at first, however, enough air to burn all the hydro-carbons. In about 45 minutes from the beginning of the operation, the oxygen of the ore and the carbon of the coal begin to form carbonic oxide pretty freely, and this is burned by mixture with the hot air from the regenerator. As this combustion of gases formed in the furnace does not sufficiently increase its temperature, a little producer gas is now let in, and its quantity is increased, from time to time, to near the end of the operation. It is probable that the hydro-carbons only increase the temperature, and that they do not assist in reducing the ore.

At this time the charge, as it rolls over in the furnace, looks like white and black gravel and sand, the white predominating. In about 1¾ hours, nearly the entire charge is at a uniform yellow heat. In about 2¼ hours, the particles of iron, now pretty well freed from oxygen, and somewhat freed from the more fusible slag, begin to stick together and to form small balls.

In about 2½ hours, the air is shut off a little, in order to preserve a reducing flame, so that the iron may not be oxidized; and the air is further decreased, and the gas increased, from time to time, till the flame is quite smoky at the end of the operation. At this time the slag tap is opened, and a little fluid slag is found to have been formed; a little more runs out every six minutes, as the tap-hole gets around to the lowest point. In about 2¾ hour; the air is somewhat more, but not entirely shut off, and the rotation is stopped for five

minutes, in order to let the ball settle together, and to let all the cinder that will run out of it get to the tap-hole. The furnace is then run for three to five minutes at about fifty per cent. above the usual speed, to facilitate the balling up of the charge. When these various operations occupy the time mentioned, the charge will be ready to draw in a few minutes less than than three hours from the time when the ore was shoveled in. A charge of the same weight has been made in about two hours and twenty minutes.

The weight of the unsqueezed balls witnessed from one of the charges was 1418 lb., and they probably contained 35 per cent. of slag, so that the loss of iron was from 18 to 20 per cent. The ore used is a very impure one, containing a large amount of alumina and phosphorus. With purer ores the loss might be largely reduced.

With regard to the results of the process, it is believed that with suitable ores, in favorable localities, it will furnish the cheapest material for open-hearth steel that can be produced by any process now working and developed. It is proved that this process removes, from ores containing a large amount of phosphorus, so much of that element that the resulting iron is quite fit for the best grades of steel.

The process is still in its experimental stage, and the cost of squeezed balls made by it has not been determined, but it is said that hammered billets made by it at Towcester cost but little over $21 per ton, the ore costing $1, hammer scale $4 and coal $3; and this while laboring under the difficulties of refractory slag, reheating, excessive waste, dear freights, small product, bad handling facilities, and all the embarrassments incident to an experimental works.

Whatever its present degree of imperfection, the process is certainly very attractive, because it makes pure iron out of impure raw material to a greater extent than even mechanical puddling; because it can work up all its own scrap, and even some of its own refuse or slag; and because it requires (when proper mechanical handling facilities are provided) the minimum of labor and attention.—*Am. Manuf.*

An Important Discovery in Upper Silesia.—The *Ztschr. für H. G. u. V.* reports the discovery of a rich deposit of pyrolusite (the bin-oxide of manganese), in the immediate vicinity of the Upper Silesian iron industry. The ore is said to contain 63 per cent. of manganese. The bed at the place where it was first discovered has a thickness of 3 metres, besides the mineral is said to permeate the rocks which lie adjacent to the bed proper. The ore is of such quality and possesses such properties that it can be put to many industrial uses, as for the manufacture of chlorine, chloride of lime (or bleaching powder), glass, paper, etc., but principally for the production of ferro-manganese. The exact locality of the deposit is not mentioned.—*Oest. Montan Ztg.*, xi, No. 26.

Refractory Materials.—Prof. T. Egleston: These materials are usually clays, which are silicates of alumina, and a few natural rocks. Rocks can rarely be used, as they are never homogeneous, and are liable to crack; clays cannot be used as they are found, but must be mixed with other substances. They are refractory, in proportion to the alumina they contain, and less useful, as they are acid; two to three per cent. of iron is sufficient to make a brick fusible at high temperature. Silica alone is exceedingly infusible, but has no binding power. The Dinas brick, which is silica, is formed by one and a half per cent. of lime, and will resist a clear, white heat alone, but is worthless if it comes in contact with metallic oxides; two per cent. of oxide of iron would make such a brick useless in a Siemens-Martin furnace. A silica brick expands to such an extent that the rods of a furnace have to be loosened while it is being heated, and tightened when the furnace cools. Alumina is also very infusible, but it contracts at a high heat, and has therefore to be mixed with silica, or burned clay, to prevent this contraction, as any depressions or contractions would make eddies in the flame and rapidly destroy the furnace. Bauxite, a hydrated compound of alumina and iron, which sometimes contains a little silica, and sometimes none at all, is also used. Siemens makes a brick of this substance which contains three to five per cent. of silica only, which is five times as infusible as the best Stourbridge brick. We have the anomaly of six per cent. of oxide of iron making one material as fusible as ordinary brick, and another, containing over 20 per cent. of the same material, being infusible. Lime and magnesia are also very refractory; they are both used to make crucibles for the fusion of platinum, but lime can only be had as a carbonate, which, under heat, becomes caustic, and when the heat is allowed to go down it slacks and falls to powder, so that it can only be used, as in Styria, in very small continuous furnaces. As lime is very friable, the campaigns are never long. Magnesia is also a very refractory material, but difficult to get. Beside the effect which the chemical composition has upon the refractoriness of materials, there is an effect due to molecular condition which has been but little studied and is still less understood.

What is demanded to-day by our present metallurgical practice is a better material than we now have. Mr. Holley has shown that the cost of refractory materials for a ton of Bessemer ingots is $1. For the Siemens-Martin process this expense is $5, while in Wales it is only $1. This shows the necessity of a careful discussion of the whole subject, which should theoretically be fusible, and then submitting them to the temperatures they should sustain, and then making a careful chemical analysis, and also a mechanical and microscopical examination.

Mr. A. L. Holley, at subsequent meeting of the Institute, in connection with this subject, presented the drawings of the details of a Pernot furnace, where it is necessary to hold up the roof, which is very drooping. This is proposed to be accomplished by the use of a lathing of water pipes; that is, letting the pipes hold up the fire brick roof, instead of the brick supporting itself. The roof is intended to be monolithic.—*Mines, Metals, Arts and Railroad Journal*, vi, 83.

—Extensive coal beds have recently been discovered sixty miles south of Portland, Oregon.

—Messrs. E. & G. Brooke, of Birdsboro, and the Phœnix Company, owners of the old Elizabeth copper mine, near Knauertown, Chester county, Pa., have leased it to Mr. Chas. M. Wheatly, of Philadelphia, who will at once open the old shafts and take out the low grade copper ores. Copper is advancing in price consequent upon the foreign war, and the business of mining and smelting this metal has become very profitable.

—Morehead & Co. lately made a shipment of iron to the Sandwich Islands.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

A New Theory of the Solar Spectrum.—*Important Scientific Discovery by Professor Henry Draper.*—At a meeting of the American Philosophical Society, held in this city, Friday evening last, Prof. Henry Draper, of New York, read a paper on his "Discovery of Oxygen in the Sun by Photography, and on a new theory of the Solar Spectrum." The coincidencs of bright lines of bands in a photograph of the solar spectrum with the oxygen lines in a photograph of a spectrum of air, was clearly shown by photographs accompanying the paper, and fully set forth in the text. It is not practicable to explain this in a newspaper report except by reproduction of the photographs themselves. Perhaps the following quotation from the paper of Professor Draper will give to scientific men a key to the nature of the discovery:

"*Oxygen discloses itself by bright lines or bands in the solar spectrum,* and does not give dark absorption lines like the metals. We must therefore change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapors, but as having also bright lines and bands superposed on the background of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, fluorine, carbon, etc., but also may account for some of the so-called dark lines, by regarding them as intervals between bright lines."

"It must be distinctly understood that in speaking of the solar spectrum here, I do not mean the spectrum of any limited area upon the disc or margin of the sun, but the spectrum of light from the whole disc. I have not used an image of the sun upon the slit of the spectroscope, but have employed the beam reflected from the flat mirror of the heliostat without any condenser."

The discovery may be considered as three-fold: first, that there are bright lines or bands in the solar spectrum; second, that certain of these lines coincide exactly with the known oxygen lines in the spectrum of air produced by the electric spark; and third, that others of them probably coincide with the lines of the metalloids, or may be referable to unknown substances. Hitherto the presence of oxygen has not been discovered in the sun, although its existence might have been suspected there on purely theoretical considerations, based upon terrestrial chemistry, the nebular hypothesis, and the fact that that element makes up eight-ninths of the water of the globe, one-third of the crust of the earth, and one-fifth of the air.

Professor Barker, of the University of Pennsylvania, who was present, said that he regarded the discovery as the most important contribution to solar physics made in America, and the most important anywhere since the discoveries of Kirschoff.

Substitute for Sand-bath.—A very convenient and easily regulated bath for heating, which may advantageously take the place of a sand-bath, except for high temperatures, consists of a solution of calcium chloride in glycerine, by which a temperature of from 572° to 626° F. may be attained.—*New Remedies*, vi, 224.

"Lacquering" is a specialty with the Chinese and Japanese. The latter assert that the art had its origin in 724, and that as early as 1290 it had attained a considerable degree of excellence, and a school was established in this branch of art named after a skillful painter of that age. The clear pure varnish, which forms so important a material in the work, is obtained largely from the gum of the tree Rhus vernicifera, a native of Japan and Nepaul. The juice, flowing from the tree when wounded, becomes thick and black by exposure, yet continues so transparent that the finest tracery is visible through it,

In beginning a decoration in lacquer, the first step taken by the Japanese is to trace out, on the thinnest of paper, the required pattern or design, and the tracing is then gone over with a bamboo spatula. The outline thus left is now gone over with a particular kind of soft lacquer varnish. When this is done in hot weather, the varnish speedily dries, and, consequently, where the pattern is a good deal involved, a small portion only is executed at one time, and the gold powder, which enters largely into the lacquer-ware for the foreign market, is applied to each part as it is being executed, a large and very soft brush being used, and by its aid the gold powder is well rubbed in with the lacquer or varnish. The work is then left to dry for about twenty-four hours, after which the pattern is lightly rubbed over with charcoal made from a particular kind of wood, and this process produces evenness of surface. The work is next rubbed with polishing powder and afterward carefully wiped. The outlining being done, there still remains a good deal of finishing work, such as tracing the leaves of trees, the petals of flowers, the wings of birds, etc. Into all this gold powder largely enters, the working in of which requires a light and skillful hand. The Chinese appear to work differently. The varnish they use is made from the sap or gum of a native tree which is dark colored like molasses. Oils are mixed with this which give it fluidity and a lighter color, but it is considerably thicker than our varnish, and can only be applied with a swab of tow. It has a poisonous effect on foreigners, causing something like our lead colic. The health of the native does not suffer, however, except when it is spattered on his lips or in his eyes. It must only be applied in damp weather, and can not be used in this country.

Another of the Chinese lacquers is made as follows: Take two parts of gum-copal and one of shellac, melt them together until entirely fluid; add two parts of hot boiled oil, and when all these are well incorporated, the vessel must be taken from the fire, and ten parts of oil of turpentine be added, stirring it in gradually. A little dragon's-blood will give it a red tint, or a little gum gutta will tinge it yellow. All the lacquered work of China and Japan is polished, and Americans have no idea of the great amount of labor expended upon this process. Luckily (?) in that country labor is very cheap. In America *we could not afford to do such lacquered work, even if we knew how.*—*The Hub*, xix, 164.

The Application of New Materials for Paper Stock, which has occupied so much attention of late, seems to have attracted some notice in the Philadelphia Exhibition last year. From Jamaica bamboo was perhaps the most important paper-making plant exhibited. Of the young bamboo stems, which are the best for the purpose, a very large supply, it is said, could be annually, by systematic cuttings or croppings, be furnished from plants flourishing in the humid parts of the island. It seems that the American paper manufacturers have also wished to make experiments with bamboo with the view, if possible, of introducing it into the American trade; so that, owing to the proximity of Jamaica to the United States, it is supposed that the supply of bamboo may eventually form an article of trade between the two countries.—*Nature*, xvi, 198.

Combustibility of Zinc Dust.—Zinc dust, so-called, is a fine, grayish powder used extensively in dye works, and consists of 40 per cent. zinc, 2½ per cent. lead, 4 per cent. cadmium, 50 per cent. oxide of zinc, 3½ per cent. carbonate of zinc, and some non-metallic dust. Such zinc dust becomes spontaneously incandescent at the presence of moisture, and has been known to cause conflagration on ship board.—*Dingl. J.* 224, 344 *Berg. u Huetten Ztg.*

On the Diffusion of Gases through Absorbing Substances.—*Poggendorff's Annal. d. Phys. u. Chem.* contains an interesting article by Sigmund v. Wroblewski, on the diffusion of gases through absorbing substances. The author made a series of experiments relative to the diffusion which takes place through caoutchouc. These experiments, made with carbonic acid gas and oxygen, seem to establish as a law that the velocity of diffusion and the volume of the diffused gas are directly proportional to the pressure with which the gas bears upon the membrane. This law was found perfectly accurate between the limited pressures (from 740 to 20 m. m.) at which the author experimented.—*Fresenius' Zeitschrift*, xvi, 231.

Electric Illumination at Sea.—The English iron-clad "Alexandra," supposed to be the finest afloat, has an electric lamp attached to its fore-mast. The cost of lamp and the necessary electric apparatus was £1,000, a sum which seems enormous at first, but does not appear so very extravagant when we reflect that it is purposed to protect a ship the insurance of which amounts to £600,000. The electric light serves two purposes, first, as a beacon light to point out dangerous reefs of rock or sand, and second, as a protection against torpedo boats. The light is thrown out from all sides of the lamp, and illuminates such a large surface of the water that it would be almost impossible for a torpedo boat to approach without detection; especially as the light falling upon the smoke would suffer such refraction as to make the boat's existence even more apparent than if the light had but fallen on its surface. This latter function of the electric light is very important, since ships have heretofore found no protection against the attacks of the torpedo boat.—*Les Mondes per D. A. Polytech. Ztg.*, v, 297.

Telegraphy in Europe.—During 1875 the number of telegrams sent in Switzerland was equal to 77 per cent. of the entire population. The corresponding population, during the same year, was 58 per cent. of the population in England; 36 in Belgium, 27 in Norway; 22 in Denmark; 19 in France and Germany; 12 in Austria and Hungary, and nearly 4 per cent. in Russia.—*Moniteur Indust. Belge*, iv, 290.

Impregnation of Wood.—According to the report of Chief Engineer R. Moser on the value of the different preservers of wood, published in the *Eisenbahn*, there are 32 impregnating establishments in Germany and Austria. Of these, 25 are in Germany and correspond to a length of road equal to 28,900 km., or one establishment to 1,000 km. of road. In Austria there is one to every 4,600 km. of road. In Switzerland, which possesses 3,000 km. of railroad, but one establishment has been founded. Of 72 railroads in Germany, 19 do not impregnate their ties, 19 employ chloride of zinc, 16 employ tar oil, 7 chloride of zinc and tar oil, 7 corrosive sublimate, and 4 sulphate of copper. In Austro-Hungary, of 49 companies, only 6, and these only in part, use impregnated ties, probably due to the fact that the low price of timber in that locality has not as yet called such attention to the necessity of preserving the wood as it has done in other countries. The Ferdinand Northern and Western road employ chloride of zinc and tar oil.

According to the statistics furnished by the different companies, Herr Moser gives the following table as showing the average durability of different woods, both in their natural and impregnated states:

	NATURAL. Years.	IMPREGNATED. Years.
Oak	13	22
Fir	4	10
Pine	5	12
Beech	3	13
Larch	5	15

In calculating the comparative cost of the different ties, the cost of impregnation (about 0.7 frcs. per tie), the interest on the cutting, loading, cartage to and from the impregnating establishment, and the other additional outlays, were added to the first cost of production. The comparative cost per tie under these conditions is as follows:

	FIRST COST.	COST OF THE PLACED TIE. Impregnated.	Natural.
Oak	6.80	8.44	7·54
Fir	3.50	4.98	4.08
Pine	3.70	5.19	4.29
Beech	4.80	6.34	5.44
Larch	4.90	6.45	5.55

—*D. Ind. Ztg.*, 1877, 246.

Carbolate of Lime for Potato Bugs.—Good authorities condemn the use of the poisonous Paris green for the destruction of potato bugs, and suggest carbolate of lime instead. They say that the latter is equally fatal to the bugs, while it is perfectly harmless in other respects.—*Boston Jour. Chem.*

Invisible Ink for Postal Cards.—The *Deutsche Illustrirte Gewerbezeitung* proposes the general use of what may be called postal-card ink, for messages which are sent on such cards, or otherwise unsealed. A solution of nitrate or chloride of cobalt, or chloride of copper, mixed with a little gum or sugar, produces a "magic ink," which is made visible by warming, either by holding against the stove or over a burning match. Potassium ferrocyanide in solution may also be used; but this requires a developer, for which either copper or iron sulphate may be employed. With the former the writing will appear in brown and with the latter in blue color. —*Boston Jour. Chem.*

A Sensitive New Barometer has been brought before the Physical Society of St. Petersburg by M. Gontkowski. In this apparatus a mercury column of invariable height equilibrates almost the whole of the atmospheric pressure, and a column of petroleum oil completes the barometric column. The barometer has at its upper end an enlargement, in which is fixed, with a plug, another tube 1.40m. in length. The two ends of this latter tube have been closed at the lamp, but a lateral slit is made in the part introduced into the enlargement of the first tube. This slit is covered with bladder skin, previously treated with benzine, and coated with a solution of gelatine in glycerine; it is firmly attached about the tube by its two edges. Thus the bladder forms a partition, at once flexible and impermeable, between the mercury filling the first tube and its enlargement as far as the plug and the petroleum of the second. Experiments have shown that the resistance of this partition to flexure produces a loss of pressure less than 1-60th m. of mercury. The petroleum is 15 times lighter than mercury, and does not emit vapor of appreciable tension at the ordinary temperature.—*Eng. Mech.* xxv, 431.

Tetrachloride of Carbon as an Anæsthetic.—In experimenting lately at the Sorbonne, with a view to industrial transformation of tetrachloride of carbon into chloroform, M. Morel found it hardly possible to obtain chloroform more cheaply by this way; but, being struck with the similarity in the formulæ of the two substances (C_2Cl_4 and C_2HCl_3 respectively) the idea was suggested to try the pure tetrachloride as an anæsthetic. He did so, and found it had superior power to chloroform, with the same general effects. The first period, that of excitation, is more marked than with chloroform; the two other periods, that of insensibility and collapse, are identical with those of chloroform. The price of this anæsthetic is less. In view of the numerous deaths which have already occurred with chloroform and ether more than 200 cases are on record), a special interest attaches to efforts to improve on these means of anæsthesia.—*Eng. Mech.* xxv, 407.

MISCELLANEOUS.

Greenheart, a Variety of Timber that grows largely in British Guiana, is a hard, close grained wood, containing a considerable amount of oil, like teak. Its specific gravity is about equal to that of oak, but it is decidedly superior to it in strength, toughness and durability. These, however, are not its chief advantages, its great value consisting in its complete exemption from the attacks of marine worms. It is, therefore, an excellent timber for sluice gates, piles, and all marine engineering works, which would be exposed to their ravages. British Guiana also furnishes morra. This tree grows to a very great size, often attaining a height of 100 to 150 feet, the lowest branches being 60 feet from the ground. The wood is extremely tough and close grained, which properties make it difficult to split, and render it peculiarily applicable to ship building purposes. It is also little subject to dry rot.—*N. W. Lumberman*, viii, 29.

Scientific Information for Ladies.—In spite of all the efforts of the educational powers that be, to spread scientific instruction among the people, the instances that daily crop up of the gross ignorance on matters of science, amongst even well-educated writers, are sufficiently amusing to the initiated. A wiseacre who has compiled the "Lady's Every-Day Book," describing castor oil, coolly informs us that "this very safe and common aperient is an oily substance secreted by the beaver. We obtain it both from Russia and America, but that obtained from the latter country is esteemed the best." We can fancy a fond mother trying to cram half an ounce of Russian castoreum, membraneous bag and all, down her lovely infant's throat, under the impression that it was a "very safe aperient."—*Chemical News.*

The Spontaneous Generation Controversy is not, it appears, to be settled by a letter to the *Times* from Professor Tyndall. It is objected that, although he has performed a series of experiments to show that putrefactive changes can arise apart from spontaneous generation, he has as yet furnished no proof that spontaneous generation does not sometimes take place under suitable conditions. It is alleged that Dr. Tyndall, and those who think with him, have never made the experiments on which Dr. Bastian bases his hypothesis, and, in fact, it is hinted that they are afraid to make them, because the results might be the same as those obtained by Dr. Bastian. It appears that the Royal Society refused to print a paper sent in by Dr. Bastian, and, if this be so, it was scarcely right for Dr. Tyndall—who doubtless has some influence with that society—to taunt his opponent, by saying that his paper had appeared only in abstract. It is an extraordinary proceeding for the Royal Society to refuse to print a paper by Dr. Bastian in its "Transactions," when the French Academy, which has also in its ranks an equally strong opponent of spontaneous generation, not only receives the communications of Dr. Bastian, but appoints a commission to inquire into the results of his experiments.—*Eng. Mech.* xxi, 430.

—W. C. Allison & Co., at Philadelphia, are building some narrow-gauge cars to go to South America.

An Oil Pipe Line in New York.—A pipe line, about three miles and a quarter long, intended to faciliate the transfer of petroleum from the New York Central Railroad Co's. oil depot at Sixty-fifth street and North river, New York, to the refinery of the Staten Oil Company at Hunter's Point, on Long Island, is now being laid down. The object of this improvement is to save the cost of lighterage and to lessen the danger involved in the modes of local transportation that have hitherto been adopted.—*Railway World*, iii, 627.

—The bark Matthew Baird has cleared from Wilmington, Delaware, with a cargo of iron rails for Brazil, and another vessel is soon to follow for the same destination, freighted with a like cargo. A Pennsylvania firm has secured a contract for a large quantity of railroad iron, shipment to be made at once. Orders are also on hand at Wilmington for a large number of cars for the Dom Pedro II and other Brazilian railways American locomotives are also gaining in favor. Wheels and other street railway material are being ordered in large quantites. These shipments are conclusive and flattering indications that this country is about to enjoy an increase in the iron trade with the Brazilian empire, and come into sharp and successful competition with European ironmasters and manufacturers of railway supplies, who have hitherto enjoyed an almost entire monopoly of this trade. The shorter ocean route from United States ports to Brazil should enable our manufacturers of railway material to increase their commerce with so desirable a market.—*Railway World*, iii, 656.

—The London *Times* taunts America with "not being able to obtain English capital for any further extension of railroad enterprises." Then we must "paddle our own canoe." While we purchased steel rails from England at $150 per ton, instead of making them ourselves at $50 per ton, she was willing to lend her capital.

—It is stated that the Cambria Iron Company is importing ore from Spain at a cost not exceeding eight dollars per ton. It yields, it is stated, about sixty per cent. of iron. It costs less to import from Spain than to bring it direct from the Lake Superior region.

—Messrs. Pusey, Jones & Co., of Wilmington, have a contract with the government of the United States of Colombia for the construction of two iron steam tugs, each 75 feet in length.

—MR. ROBERT O'NEILL of Jacksonville, Fla., claims to have invented a process by which saw-palmetto can be converted into pulp for paper at a cost not exceeding $5 per ton.

—The orange product of Florida for the year 1875 is estimated at 17,000,000; of which Indian river produced 536,000; Sumpter county 1,000,000; Orange, 1,000,000; Liberty, 225,000; Franklin, 200,000; Calhoun and Jackson, 400,000. The writer in the *Florida New Yorker* who makes these estimates, says that ten years hence the cities of New York, Philadelphia, Baltimore, and Boston, will derive their principal supply of oranges from Florida instead of the West Indies.

THE LOUISVILLE INDUSTRIAL EXPOSITION.—From a circular letter just received we glean that the exhibition to be held in Louisville this season will be opened on September 4th and close on October 20th following. No charge will be made for space, but applications must be made on or before the 16th day of August. Applications after that date will not be allotted space until those received previously have been assigned. Applicants must state the exact amount and kind of space required for the exhibition of goods, without reference to the space necessary for visitors. The exact size of counter or show-cases, and an accurate plan of the floor-space required for machinery, must accompany each application.

— The Keystone Bridge Company, of this city, has received the intelligence that it is the successful bidder for the building of a wrought-iron bridge over the Ashtabula River, on the line of the Lake Shore Railway, to take the place of the one on which the terrible disaster occurred last December. The Keystone Company was not the lowest bidder, but its plan, it seems, is considered the best. The bridge is to be a single span, 156 feet long, and for a double track. The style of the bridge will be the Linville truss.

— The sixth annual meeting of the American Association for the Advancement of Science will be held at Nashville, Tenn. The session commences August 29th and lasts to September 5th. Excursions have been arranged to important districts in the South and Southwest.

— The production of coal is increasing. By comparing the statistics of tonnage of this year with the same time of last, the anthracite shows an increase of about ¼; bituminous, for the same time, a decrease of about 1-240.

— The Baldwin Locomotive Works are in receipt of additional orders for steam street motors.

— Richmond, Va., has 343 factories, which employ 11,000 persons.

— Stearns Manufacturing Company, of Erie, made and sold 480 oil-engines during the year ending June 10th.

— A kiln for the manufacture of chinaware has been erected in Berks county, near Lobachsville, and bricks were burned in it for the purpose of lining the oven. The person having the enterprise in charge is confident that he can make the purest kind of chinaware from material found in the vicinity.

ANSWERS TO CORRESPONDENTS.

SHEER POLES. (G. T., Philadelphia.) As the ends in the case mentioned are rounded, they will bear only about one-third as much weight as if the ends were flat and fixed. Wrought iron is sometimes used, despite its lack of great compressive strength, because it is convenient to work into tubes. They are stiffened by internal T irons or L irons as ribs. A weight of thirty tons would be apt to "pull out by the roots" sheers made and planted as per the sketch sent, and we advise putting up heavier shears and anchoring them better.

CORE VENTS. (H. D. A., South Bend.) These are for the purpose of carrying off the gases generated *in the core itself.*

QUALITIES OF WOOL. (H. B. M., Greenwich). The finest is on the spine, from the neck to within six inches of the tail, and including one-third of the breadth of the back or saddle. The next grade is on the flanks from thighs to shoulders. The third covers the neck and rump; the fourth on the lower part of the neck and the breast down to the feet, also upon a part of the shoulders and thighs to the bottom of the hind quarters.

MOHAIR. (M. R., St. Paul). Most of the mohair that we get is goats' hair, or rather the *wool* of the Angora and kindred wool-bearing goats.

STAYED LINKS IN CHAINS. (P. F. L., Pittsburg). These are one-half stronger than open links of the same rod. The stay prevents the collapse of the link and thus prevents the link from *shearing each other open,* by wedging. This is all the philosophy of the matter that occurs to us. Stayed-link chains are heavy and work very roughly on pulleys.

TO DYE HORN WHITE. (L. J., Water Gap). We presume that you do not mean bleaching, but actually fixing in a white coloring matter. Dip first into a salt of lead and then into hydrochloric (muriatic) acid.

THE ELECTRIC PEN. (W. H. R., Hinsdale, N. H.) This does not write with an electrical current, but the perforator is driven by an electro-magnetic battery.

BLOOD-BREAD. (R. H. S. Macon). The idea is a good one and need not be at all revolting. People who eat kidneys and liver need not turn up their noses at good sweet blood.

COPPER BOILERS. (D. J., Ithaca). These are too expensive. Sulphurous coal injures them; leakages of salt water damage them by incrustation more than iron. They lose tenacity by heating. But salt water does not damage them inside as much as it does iron.

WHY THE ENDS OF TEST BARS ARE ENLARGED. (T. B. B., Philadelphia). This is to give a good grip. A round form is chosen for the test section as being more readily produced and gauged than any other form.

TIN SPOTS IN BRONZE. (W. C., Pittsburg). The tin spots in castings referred to in our article on metal bearings, are not all tin, but have say 25 per cent. of that metal. The alloy should contain about 10 per cent. tin to 90 copper; the increased proportion in the spots would not much affect the other portions.

PLASTIC VS. ELASTIC. (W. I., Newark, N. J.) Putty, lead, etc., are plastic. They are not *absolutely* non-elastic, but practically so. Water is slightly elastic under compression; of course not elastic under extension, as it is not capable of extension.

HORSE HAIR CLOTH. (R. R. T. Dubuque). One of the principle troubles in weaving hair-cloth arises from the fact that the hair is not round in section, but appears as though one-third of the circle had been cut out and the flat portion slightly indented. Such a fibre is hard to handle, especially when in such short lengths (16 inches and upwards).

ARTESIAN WELL. E. L., Fall River). Your plan of digging a well and then boring ten or twelve holes at the bottom instead of one, is not new. The great Bootle well near Liverpool, in the new red sandstone, has 16 or 17 borings; and on plugging up all but one the yield was found to be nearly as much as from the whole number; showing somewhat of a waste of capital.

EARTHENWARE INVERTED SIPHONS FOR WATER WORKS. (S. P. T., Jr., Norristown). You will not find these strong enough if the fall is greater than 1 in 300.

STERRO-METAL. (D. R. J., Peoria). This is copper, zinc, tin, and wrought iron. It is intended for guns. The name means "firm" or "solid" metal. Rosthorn introduced it at Vienna. It is very difficult to get homogeneous castings of it. One specimen breaking at 37·0 gross tons per square inch of section, was made of copper 57·63, spelter 40·22, iron 1·86, tin 0·15; drawn cold and reduced from 100 to 77 transverse sectional area.

NORMAL AIR. (A. M., Exeter, Me.) Very pure air contains 20.999 per cent. of oxygen and .03 per cent. (that is, $\frac{3}{10000}$) of carbonic acid. If the oxygen fall below 20.75 the diminution is sensibly felt.

SEASONING TIMBER. (H. R., Crestline, O.) This nearly doubles its strength.

ROPE SIZES. (T. & B., Nashville). A six inch rope is only six inches *in circumference* and hence only $\frac{6}{3 \cdot 1416} =$ about 1.9 inches in diameter, and hence not such a large one, nor so weak for the strength referred to, 10½ tons breaking strain.

EDITORIAL CORRESPONDENCE.

Messrs. Editors POLYTECHNIC REVIEW: On page 19, current volume, your valuable paper contains an article, by Mr. J. Haug, on Schiele's curve, in which the assertion is made that "the pressure (at right angles) to the surface is increasing as the radius decreases." Now the fact is, that the shape of this curve is based on the supposition that "the pressure (at right angles) to the surface is uniform over the entire bearing surface;" but the taper (to use a common expression) is varied in such a proportion that the less wear on the smaller radii allows the same "set" as the greater wear on the greater radii. An equal "wear" all over the surface would soon produce a clearance on the lower portion of the surface, as such a wear on the more taper portion would require more set.

HUGO BILGRAM.

Philad'a, July 14, 1877.

Editors of POLYTECHNIC REVIEW: In the last number of the REVIEW we are informed by Mr. Haug, that "by constructing a pivot with Schiele's curve, the pressure at right angles to the surface is increased in the same ratio as the radius decreases, and thus the work of friction and consequent wear is kept uniform." Fortunately for Shiele, this assumption is very far wide of the truth. If it were correct the curve would be of no value for the purposes to which he applied it. A step correctly formed to this, curve and having a well-fitting bearing, will retain the same form even after a large part of its material is worn away. It follows that the rate of wear, measured, *not* on lines normal to the curve, but *on lines parallel to the axis,* will be alike on all parts of the surface. This being the case, it may be readily shown that the rate of wear, *measured on a line normal to the curve* at any point, must be as the diameter of the step at that point. But, this rate being as the pressure multiplied by the diamerer, the pressure will be a constant factor; that is, it will be uniform over the entire surface. A step of any other form, revolving under pressure sufficient to cause perceptible wear, will at once begin to lose the equal distribution of pressure, no matter how nicely it may have been effected by careful workmanship in the first instance. C.

Philadelphia, July 17th, 1877.

BIBLIOGRAPHICAL NOTICES

COMPOUND ENGINES. Translated from the French of A. Mallet. 82 pp., 24mo, boards. D. Van Nostrand, New York.

This little work, which is No. 10 of the "Science Series," is generally correct in its statements, and contains some good explanations about condensation in cylinders, and steam jacketing. But there are many mistakes in the formulas and calculations, and much ambiguous and confusing language. The translations are much too literal and Frenchy. There is some nonsense on pages 23 and 34. On page 36, formula $n' \frac{\log n}{n'}$ should be $n' \frac{\log n}{\log n'}$. Pages 42 and 43, strokes and revolutions are considerably mixed, and we do not understand the expression (p. 42, 9th line), 11.65 H. P. of sensible steam acting on the piston. A cubic meter of steam at 5 atmospheres does not weigh 2600 kilogrammes (about 2¾ tons), as per page 47. We suppose from the context that by "stamping engines," page 82, the translator (evidently not an engineer) means *steam-hammers;* and we wish that some one better posted had translated what is doubtless an excellent work in the original.

TOLHAUSEN'S TECHNOLOGICAL DICTIONARY.—This work, in the English, German and French languages, contains about 76,000 technical terms. It is in three volume-parts—English-German-French, German English-French, and French-English-German. The editor is Dr. Alexander Tolhausen, translator to the Great Seal Patent Office, and the work is revised by Louis Tolhausen, French consul at Leipzig. The imprint of Baron Berthold Tauchnitz, whose famous "Leipzig editions" are familiar to most of our readers, inspires confidence in the accuracy, and three weeks' practical test in this office of translating from the French and German warrant us in commending the publication as both thorough and accurate. The work is received from Messrs. Henry Holt & Co., New York.

SELECTED LIST OF U. S PATENTS.

JULY 3d, 1877.

The Patent Office Bar Association has taken commodious rooms in the building 633 F street, in the city of Washington, but a few steps from the Patent Office, and they are now being fitted up for the use of the Association. In these rooms members of the Association will find every accommodation and convenience for making searches and examinations,—better facilities, in fact, than can be secured in the Patent Office itself; and the rooms will be kept open through the day and evening,—the latter especially for the accommodation of members who do not reside in Washington, and desire facilities for work out of office hours.

S.

Patents issued July 3, 1877, 255. Reissues, 16. Trade marks, 38. Designs, 12. Labels, 7.

192,571.—MACHINES FOR WARPING YARNS. John Cumnock, Great Falls, N. H.

The yarn, as it is wound upon or off the beams, is relieved from leaf, motes, &c., by means of a brush, which is fixed to pivoted and weighted levers to keep it continually pressed against the yarn upon the beam.

192,577.—WRINGER ROLLS. J. Greacen, Jr., New York City.

The surface of the roller-shaft is cleansed of impurities either by chemical means or by turning it off in a lathe. The rubber is then vulcanized directly upon the metal.

192,580.—SHUTTLE-BOX MECHANISMS FOR POWER LOOMS. P. Hickey & C. W. Miles, Auburn, N. Y.

The boxes are mounted in a slide frame that is adapted to be reciprocated in a stationary frame connected with the main frame of the loom. The series of boxes consist of rotating and non-rotating boxes,—the former surmounting the latter, and both secured to the same slide-frame. The invention consists in this special combination, and also in a combination of mechanism for revolving the aforesaid rotary boxes.

192,602.—DOOR SPRINGS. L. P. Sherman & P. M. Berry, Biddeford, Maine.

A spiral spring is arranged on a metallic rod, between an upper and lower ring or sleeve, with notches and serrations to regulate tension, and is provided at its upper end with a short arm, carrying an anti-friction roll. There are also two arms, one secured to the spring, and the other to the door, pivoted in the middle, thus constituting a toggle lever; the construction being such that the short arm and toggle may be so arranged with reference to each other that when the gate or door is thrown open, the roller will pass backwards to hold it open, and also such as to cause the gate or door to close wthout slamming.

192,615.—MACHINE FOR MAKING RECTANGULAR BANDS. M. Blakey, Etna, Pa., assignor to J. I. Robertson and G. A. Chalfant, same place.

There is is a rectangular mandrel, and lobed rollers are arranged equidistantly around it. The lobes are of such curvdture as to conform to the rectangular sides of the mandrel as they are all simultaneously revolved. A heated blank of suitable size is fed between the mandrel and one of the lower rolls; is deflected by the guide block and caught by the opposite lower roll, and forced to conform to the shape of the mandrel as the rolls and mandrel simultaneously revolve.

192,635.—APPARATUS FOR REFINING AND AGEING ALCOHOLIC LIQUORS. George Clark, Buffalo, N. Y.

The liquor is heated with a steam coil, and is circulated and sprayed by a pump, connecting pipes and a perforated tray. Air, previously strained through cotton, is drawn through the sprays of liquor by an exhaust pump. Vapors of liquor, carried over by the air currents, are condensed in a worm condenser, and the condensed liquor is collected in a separate vessel.

192,655.—BOBBIN HOLDERS AND BOBBINS FOR STUBBING AND FLY FRAMES. Martin J. Neilson and Timothy Higgins, Chester, Pa.

The holder has an angular or eccentrically-shaped recess in its top, into which a similarly shaped bottom of the bobbin fits. Old bobbins may be cut away so as to fit said recess, and be used over again.

192,656.—SAFETY PULLEY. Emery Parker, New Britain, Conn.

The pulley is loose upon the shaft, and by the side of it is a plate fixed upon the shaft. A spring-catch couples the pulley with said fixed plate, and maintains said connection until the strain reaches a maximum in excess of the necessary driving strain. When the strain of the driving belt exceeds said maximum, the spring-catch is overcome and disconnected, so as to let the pulley run free.

192,659.—LOOMS FOR WEAVING LOOPED OR PILE FABRICS. John Rothwell, Philadelphia, Pa.

This loom is especially adapted to weave Turkish toweling, having a looped body or main portion, with borders of plain weaving. The Terry warps, as is usual, are mounted upon a separate warp beam, which is adapted to give off the warps more freely than the beam carrying the body warps. The loose reed is automatically locked at regular intervals,—the latter being determined by the shape of the cams. When the reed is loose, the wefts are laid in without being driven home; but when the reed is locked, the wefts are beaten up, and the warps, being freely drawn off, form loops on both sides of the fabric. To make a plain fabric, the reed is locked by a device under control of the weaver, and is relieved from the action of the cam.

192,666.—MACHINE FOR MAKING HORSE SHOE NAILS. John E. Wheeler, Lynn and David B. Loring, and Frederick W. Coy, Boston, Mass.

Blanks are ejected, one at a time, from a removable box, and slide down an inclined way to the feed-tunnel, which contains, in addition to the divided detent described in the patent of Loring, Nov. 23, 1876, No. 184,719, another detent to arrest the descent of the blank at a point above the divided detent. A delivery-tunnel, held in place by spring pressure, presses back a spring arm, the point of which is intended (when the delivery-tunnel is pressed down by an imperfect blank in a die roll) to enter the feed-tunnel below the lower detent, and intercept or prevent further feeding of blanks to die rolls.

192,669.—MACHINE FOR MAKING PICKER TEETH. Robert Aldrich, Millville, Mass.

The die rolls feed the rod, and impart the desired shape; and the punch, working in harmony therewith, advances to sever the pins and cut the teeth, advancing and receding alternately.

192,682.—STOP-MOTION FOR DRAWING FRAMES. J. B. Clark, Woonsocket, R. I.

When the sliver is run through the trumpet, the catch is held up; but when it breaks, the weighted lever falls and stops the machine. The lever upon which the catch is formed is in two parts, shouldered and pivoted together, and provided with a longitudinally-extending spring, which permits of a limited downward bending of said lever. The tension of said spring may be adjusted by a screw-threaded stud, working in a longitudinal slot.

192,692.—SPINDLES FOR LOOM SHUTTLES. James Hamilton, Salmon Falls, N. H.

The point of an auxiliary spindle is adapted to slide in a groove of the main spindle. At the outer end of said groove is a socket. The spindles have their pivots arranged in such relation to each other that when said spindles are turned down into the shuttle, the socket of the main spindle limits the longitudinal motion of the auxilliary spindle, and forces the latter to bend outwardly, thereby firmly holding the cap.

192,738.—CAPSTAN AND PROPELLER ATTACHMENT FOR VESSELS. W. H. Churchill, New London, Conn.

The capstan shaft extends down through the deck to a step above the propeller shaft, where it is provided with a worm wheel. The propeller shaft is provided with a pinion, and this meshes with a similar pinion on a counter shaft, and the motion of the propeller shaft is transmitted through said pinion and counter shaft and a worm thereon to a worm wheel on the capstan shaft.

192,810.—FOOT-POWER BAND SAWING MACHINE. Frank Millward, Cincinnati, Ohio.

The saw frame is provided with an adjustable seat, and the motive power is applied by the feet upon a double crank wheel. The guides are adjustable to admit of the saw being run at different places on the band wheels.

THE

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DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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Fig. 3.

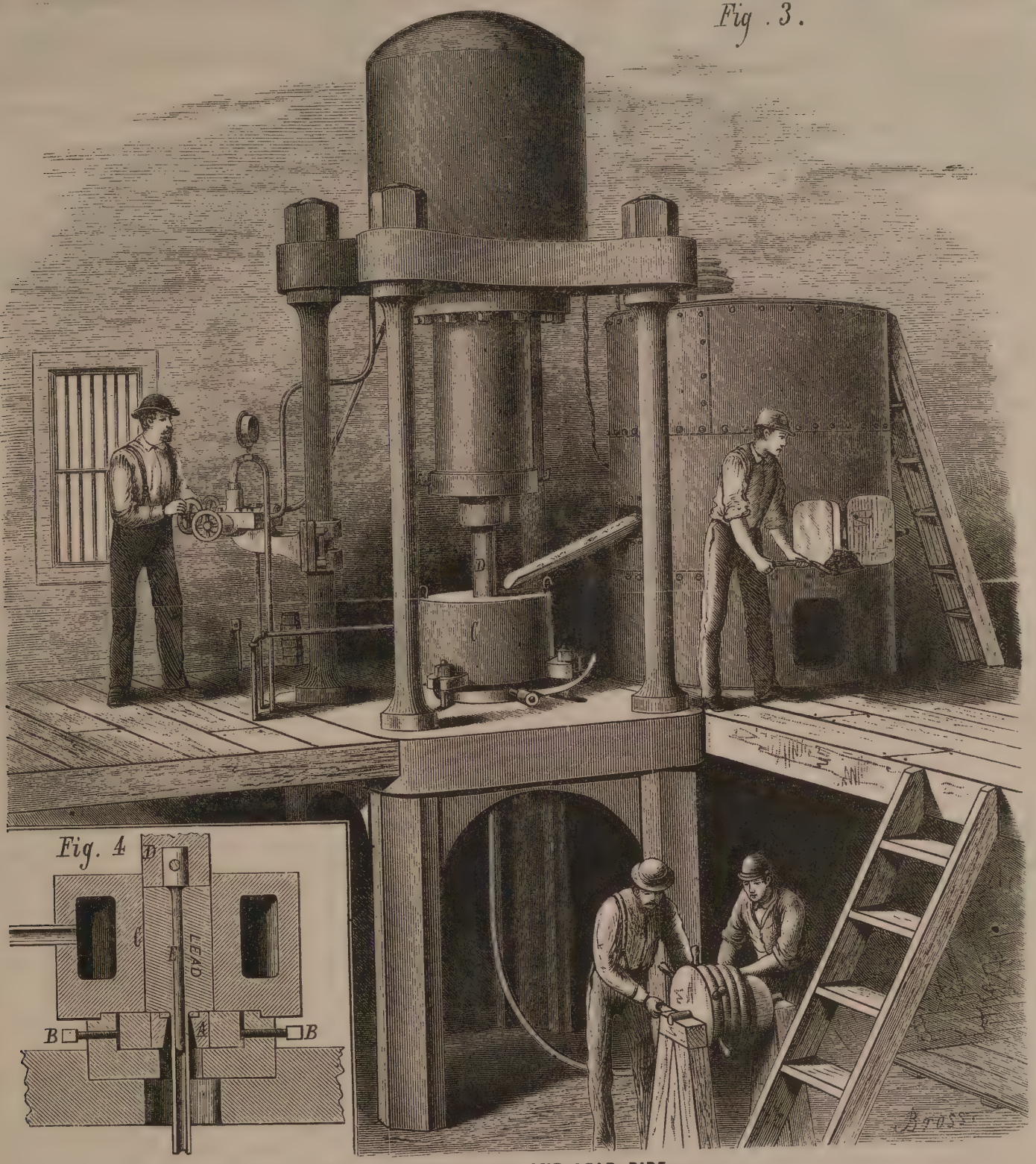


Fig. 4

SHEET LEAD AND LEAD PIPE.

Outside of the question of the manufacture of ten-cent pieces and quarters, which seems to be a rapidly growing industry, carried on in secret or not advertised, unalloyed lead is worked up into two forms: sheet and tube; and possibly we might include lead bar or rope, sometimes used for making conical bullets. Shot contain arsenic to give them hardness, and their manufacture will come under a different heading.

Lead is a soft, ductile and malleable metal, with a specific gravity of 11.41, and weighing about 711 lbs. per cubic foot. It has very slight tensile strength, (about 1800–3300 lbs. per square inch, ascending as it is cast or milled,) melts at 600° F., and makes tolerably sharp castings on account of its fluidity when molten. As a conductor of electricity it comes between *antimony* and *bismuth;* as a conductor of heat it ranks the lowest on the scale of metals.

Spanish lead reaches us in pigs of 150 to 175 lbs. each, which are quite pure, having been refined before shipment, and much of American lead, especially that coming from west of the Rocky Mountains, contains silver, and is subjected to a refining process for the extraction of the precious metal. The baser metal sells for about the cost of refinement, leaving the silver as profit. The extreme malleability of lead renders its formation into sheets quite an easy task, while its ductility or ease of flow among its particles render its formation into pipes comparatively easy.

To make sheet lead, the pigs are first melted in quantities of about ten tons at a time, and run in iron moulds into cakes about seven feet ten inches long, five feet wide, and four inches thick, weighing about four and a-half tons. Such a cake requires two hou s to cool, and when solid is lifted out of the mould by the chains shown in Fig. 1, and trimmed with an adze. This cake is now ready for rolling into sheets. It is next carried to the mill, (Fig. 2,) which has a horizontal cast iron cylinder thirty inches in diameter, and nearly nine feet long, and weighing about eleven tons, mounted in proper housings and provided with screw adjustments to regulate the thickness of the sheet lead desired. The table is a series of small iron rollers in two parallel lines, these lines having between them a rack whose teeth serve as fulcrums for levers to push the cake under the top roll.

In Fig. 2 the melting furnace and its crane are seen in the distance; the railroad with its car load of pigs is seen in the left foreground. The drum-hoist over the roll-table is for the purpose of drawing the cake from the end of the table (where it is deposited by the crane) to its proper position in front of the rollers.

The cake is placed with its greatest length (seven feet ten inches) with that of the cylinder, and is by repeated rollings, say one hundred and fifty passes, (the top roll being lowered each time by the hand-wheel shown at the right,) rolled into a sheet thirty feet long, seven feet ten inches wide, and a half-inch thick, and weighing about thirty pounds per square foot.

This sheet is cut up into smaller pieces, varying from three to eight feet in

Fig. 1.

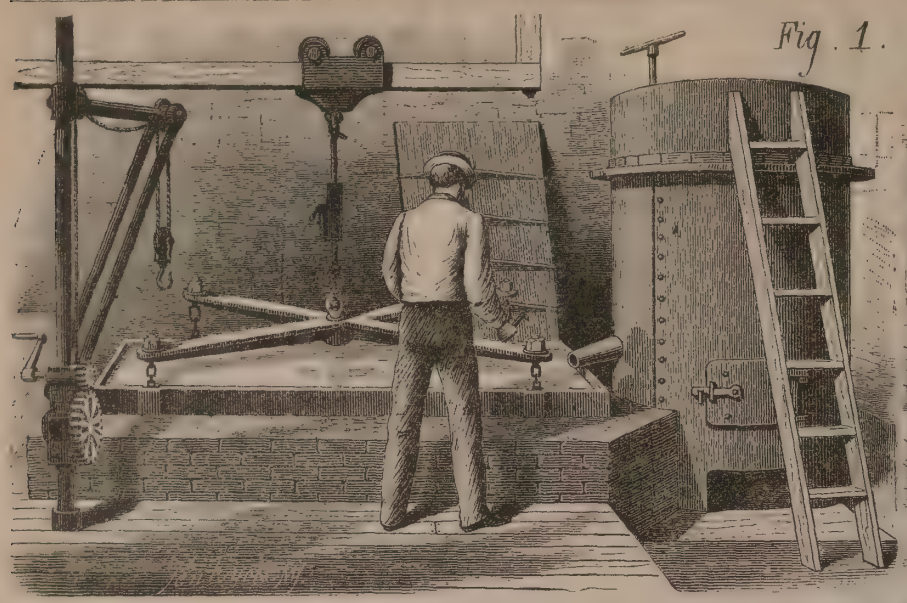
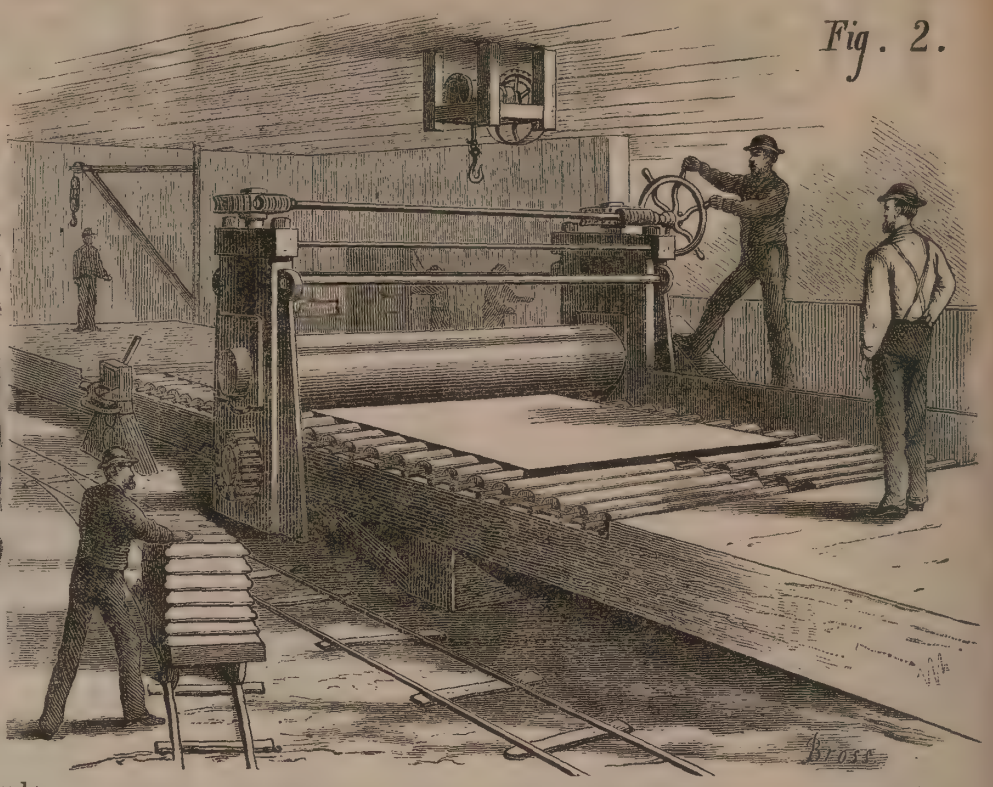


Fig. 2.



length, according to the weight per roll required, by vertical knives actuated by a screw, and moving across the rolling table between the bottom rollers. These smaller sheets, weighing 337 lbs. each, are next rolled out into strips generally about eighteen feet long, seven feet six inches wide, and from $\frac{3}{32}$ to $\frac{3}{16}$ of an inch thick, weighing from 337 to 800 lbs. each, or two and a-half to fourteen lbs. per square foot. Any required length is made. These strips are rolled up for market, constituting the usual sheet lead stock; the gradations being by one-half lbs. between two and a-half and five lbs. per square foot, and by pounds between five and fourteen lbs. Their principle use is for lining sinks, tanks, cisterns, etc. A very important use is the lining of sulphuric acid chambers and concentrating pans for chemical purposes, where they are joined by what is called "autogenous soldering," or actual fusion together of the edges of the sheets, as soldering would cause galvanic action and rapid corrosion. For this reason it is essential that the sheets be pure and homogeneous. The Chinese make a very thin sheet lead for lining tea-chests, by casting a large flat slab, and while yet pasty spreading it out (by means of a large stone) into very thin sheets. The so-called "tin-foil" or tin leaf is made by placing a sheet of lead between two layers of the less flexible and malleable tin, and rolling and re-rolling the triple sheet down to the thickness used for wrapping up tobacco and for other purposes where it is desired to exclude or retain moisture.

In the manufacture of lead pipe the "flow of metals," possessed in a high degree by lead, is utilized. It would be possible to form lead pipe from cold metal, but the power required for this would be too great for practical use, and the metal is treated in a viscous (or semi-fluid) condition. A die and core, just as in making maccaroni or drain pipe, are employed. Their section is shown in Fig. 4: *A* being the die, with flowing mouth to prevent friction, and *E* the core or mandrel, between which and the die the hot viscous metal is forced by the descent of the press plunger *D*. The cylinder *C* has a steam jacket. The metal die *A* rests on a collar *B*, in which it has a centering adjustment by means of the set-screws *B B*, and which rests on the bed piece below. The smallest diameter of the die-aperture fixes the outer diameter of the pipe; the diameter of the core or mandrel *E* determines the bore, and of course the thickness and weight of the pipe are determined by the difference in diameters and in area between the die and the core.

Fig. 3 shows the melting furnace at the right, and in the centre the hydraulic press, having a stroke of four feet, the water cylinder having a diameter of twenty inches, (314 square inches area), and the metal cylinder six inches diameter, having an area of twenty-nine square inches. As the water pressure employed is about 3000 lbs. per square inch, or 9.42000 lbs. upon the 314 square inches of the water piston area, we must expect to find a pressure of 32483 lbs. per square inch upon the lead in the lower or die-cylinder. The melted lead is run right out from the kettle into the plunger cylinder, and at once put under pressure until partially congealed. When one charge is nearly exhausted more molten metal is run in, so that pipe can be run out of any length continuously. Heavy pipe requires more frequent refilling of the chamber. Thus an "extra light" pipe of an inch bore (one-eighth inch thick) weighs two lbs. to the running foot, and if the chamber holds 135 lbs. a single full descent of the plunger would run out $\frac{135}{2} = 67\frac{1}{2}$ feet of pipe. To produce different sizes or thicknesses of pipe, the dies or cores are changed, the die being removed by lifting the chamber *C* by means of the press plunger.

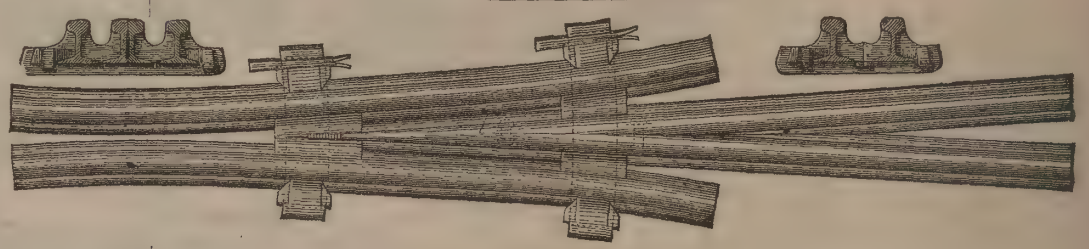
To produce tin-lined (which weighs the same as lead pipe of the same bore and thickness) is a curious but simple matter. There is a vertical mandrel inserted in the die orifice projecting upwards into the press chamber, and consisting of a central stem with dovetailed lapping section surrounding it. The lead is let in surrounding this compound mandrel. The outer sections of the mandrel are then removed and tin let in between the central stem and the lead; the mandrel is then substituted by the regular core, and the compound cylinder of lead with tin center is pressed into a pipe of lead with thin tin linings. The sides of the mandrel having several stips or shoulders with a different taper from each, the tin has several abutments or purchases against the lead, to aid in causing them to flow together properly.

Lead pipe has the advantage over iron in being flexible, and hence easier carried around corners or clamped in position; but if unlined it is slowly but surely dissolved by most drinking waters—the purest affecting it the most, and hence most likely to produce lead poisoning.

As tin is not oxidizable by air or water, and unaffected by ordinary acids or alkalies, the tin-lined lead pipe should afford the desirable advantages of convenience and safety.

As regards the sizes of lead pipe, it runs from one-eighth to one-quarter inch bore, under the name of tubing; these sizes weighing two and five ounces per foot. As ordinary lead pipe we find it from three-eighths to three-quarters inch bore, inclusive, varying by one-eighth inch; then varying by one-quarter inch up to one and one-half inches, and then two inches. From one and one-half to 5 inches bore by one-half inches, we have "waste pipe" of which there is also a six-inch size. As regards thickness, there are grades from "extra strong" to fountain size.

We are indebted to the courtesy of the Colwell Lead Co., of New York, for much of the information contained in this article. G.



PATENT KEYED FROG.

"This frog has, after a thorough test, been adopted for a *standard stiff frog* by the makers*, and is worthy of the careful consideration of all parties interested in the construction or maintenance of railroads, for its simplicity, strength, durability and economy.

It is made of best quality steel rails; the pieces composing the point are dovetailed in the usual manner, and riveted together with heavy rivets. The requisite "throat" space is obtained by solid iron throat-pieces between the point and wing-rails (see cut). These throat-pieces fit the rails perfectly, and at the point they extend beyond it, thoroughly bracing and staying it against lateral strains. The parts of the frog are immovably secured together by heavy binding bars beneath the rails—the ends of the bars being turned up to a suitable angle—acting in conjunction with brace blocks outside the rails, and keys (or wedges) which are driven between the brace blocks and the binding bars. The brace blocks are made to fit closely to the rails, bearing on the upper side of the flanges (or base) and the under side of the head of the rails, and they have on the outer edges bevels suited to the angles of the binding bars and keys.

The keys are thickest on the lower edge, being beveled unequally, which shape, in connection with the peculiar angles of the binding bars, prevents the keys from working upwards; the keys are also split lengthwise for some distance, and after being driven in by sledges to the extent required to hold the parts, the split ends are spread open to prevent the keys from working out. The brace blocks as well as the throat pieces bear equally on the top of the flanges and under side of the heads of the rails, and the whole structure of the frog is prevented from rising or working away from the binding bars by the beveled surfaces and the keys.

This method of securing the parts together is claimed to have advantages over bolts passing through the parts, often employed, on account of the much greater degree of solidity with which the parts can be held together, and the greater security against becoming loose, requiring less care and attention to keep tight. Should the parts, by long-continued use and lack of attention, become loose, the throat pieces and brace blocks are prevented from shifting by the lugs which fit the edges of the binding bars. The peculiar construction of the parts should also prevent any shifting of the parts.

In laying this frog there is no cutting of the cross-ties, as they come between the binding bars, giving full opportunity to use the usual spikes to secure the frog in place; and, the point rails and wing rails being drilled for splice plates, the frog is fished directly into the track as complete as any part of the line.

It will be noticed that the rails composing this frog are not drilled, nor their strength in any manner diminished, and that the full measure of the elasticity of the rails is retained in the frog, without liability of breaking rigid filling or loosening the parts in any way, thus enhancing the durability of the frog, in the case of unequal ballasting or otherwise and tending to make the frog easy to pass over. Repairs to this frog while in the track are very readily made, as by simply backing out the keys, parts can be renewed and the whole secured again in a few minutes."

*The Pennsylvania Steel Company, Steel Works P. O., Pa.

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

THE BEET ROOT SUGAR INDUSTRY.

BY LEA PUSEY.

III.

BENEFITS TO BE DERIVED FROM ITS INTRODUCTION INTO THE UNITED STATES, TO AGRICULTURE, TO THE MECHANICAL INDUSTRIES, TO THE IRON MANUFACTURER, TO THE COAL TRADE, ETC.

The production of sugar may be very properly classed with that of wheat, corn, cotton, wool, &c., which are the foundation or basic industries of this country, on which public prosperity and industrial progress rest. Iron is mined, manufactured, and converted into machinery by the cunning hand of industry, with which it also transforms these materials into articles of food, clothing, and the manifold devices of use and ornament, and then conveys them to the consumer; thus giving employment to industry, and furnishing its reward. Coal is mined, used in refining the iron, and co-operating with it in the beneficient routine of manufacture, distribution, and reward to industry. Our country glories in its progress towards self-dependence for the supply of its wants, and a bountiful nature has richly gifted us; but for our supply of sugar, become so necessary in the food of modern society, it is most dependent, and if by any cause, and there are many, the supplies should be decreased, and this is the condition at the present time, we will pay dearly for this neglect.

With this condition now, and the possibility of its being worse in the future to impel, what additional inducements are there to attract this industry amongt us?

Our country imports nearly one million tons of sugar per annum. This, if made at home, would require two million tons of coal directly in its manufacture, and a large increase, indirectly, from the effect on other industries.

Business men engaged in the coal trade, cannot you see your interest in uniting with others, to start this industry on a solid basis? It would require about 12,000,000 tons of beets for this sugar, using 1,000,000 acres of land, one ton of sugar per acre, the European average. Here is an additional crop for the farmer, and one which judging by European experience will increase their incomes. Grangers, your organization is especially for the benefit of the farmer; here is something for you to do. See if their interest would not be promoted by uniting with the coal interest?

From seventy-five to one hundred million dollars worth of machinery and buildings would be required. Manufacturers, merchants, and consumers of iron, see how it would help to increase the home demand for your merchandise, lumber, stone, brick, lime, and all supplies for building and the multiplied interests connected therewith. Cannot you be prevailed on to co-operate for your own interest.

Two million tons of coal, and twelve million tons of beets, have to be brought together annually, and the thousands of tons of other material for the building up of this industry; carriers of freight, do you not see your interest in intimate connection with the promotion of this enterprise? Cotton, woolen manufacturers, and merchants, who are now seeking for consumers of your goods, while thousands of our fellow countrymen are poorly clothed and unable to supply their wants, because of poverty, and enforced idleness, this industry would furnish labor for them, and increase business for you.

There is scarcely an industry or interest in any department of human effort in this country but what would be benefited by the addition of this as an important complement to the circle, for the supply of human wants. The large proportion of the business of the country is now languishing; at the same time millions are paid annually to foreign nations for sugar that can and ought to be made at home. Capital has been frightened by the fearful slaughter of it in railroad ventures, so that new untried investments have no attention. Therefore this industry requires the organized efforts of those interests which would be directly benefited to place it on a basis to insure success, and demonstrate, by the most positive evidence of facts, that it will and does pay. One well organized and model establishment will give it such an impetus, as soon as successful, that but little more would be required. This could not be done in one year; it would probably require several, and the patient perseverance by those who engaged in the enterprise.

THE CULTIVATION OF THE SUGAR BEETS FOR FORAGE ALREADY ESTABLISHED IN THIS COUNTRY—THE COST—COMPARISON WITH OTHER CROPS.

That sugar beets have been grown quite extensively in certain localities in this country for winter food for cows, is not new. They are esteemed by many dairymen superior to all other root crops for that purpose, and some facts in relation to the yield per acre, and cost per ton, are herewith inserted.

P. T. Quinn, of Newark, N. J., manager of the farm of the late Professor Mapes, says that after land has been "broken up" he can cultivate sugar beets at $16.00 per acre, in the best manner, not letting a weed show itself, and obtain crops of from 25 to 30 tons per acre. The above amount covers every expense, including harvesting.

J. C. Thomson, of Staten Island, has obtained 40 tons, can average 30 tons per acre, at a cost not exceeding $25.00 per acre.

Emory Rider has raised 30 tons per acre at Hackensack, N. J., and could count with certainty on 20 tons per acre, at a cost not exceeding $28.00 per acre.

The Scientific American of April 3d, 1869, publishes the following exhibit in tabular form, it being the result of the experience of 18 persons, and shows a great variety of cost and yield:

No. 1,	product	17 1-4	tons per acre,	cost	$4.05 per ton.
" 2,	"	17	" "	"	2.23 "
" 3,	"	34	" "	"	2.38 "
" 4,	"	49 1-2	" "	"	1.15 "
" 5,	"	25	" "	"	64 "
" 6,	"	30	" "	"	84 "
" 7,	"	20	" "	"	70 "
" 8,	"	20	" "	"	1.50 "
" 9,				"	2.00 "
" 10,				"	3.00 "
" 11,				"	2.65 "
" 12,	"	20	" "	"	1.50 "
" 13,	"	15 to 42	" "	"	2.00 "
" 14,				"	3.50 "
" 15,	"	20	" "	"	1.38 "
" 16,	"	20	" "	"	"
" 17,				"	2.60 "
" 18,	"	13	" "	"	3.00 "

The average yield is 24.48 tons per acre, and average cost $2.42 per ton.

Taking the above data, it is evident that the average cost per ton, for an average crop of 15 to 20 tons per acre, is under $2.00. $3.50 to $4.00 would be about the value of the sugar beet containing 11 to 13 per cent. of sugar. This would nett $25 to $40 per acre, clear of cost. Compare this with the following report of the Agricultural Bureau of the average yield per acre and cash value of the grain crops in the United States for 4 years.

Corn,	32.99 bus.	per acre, at	$0.86	per bus.,	$28.57 per acre.
Wheat,	14.34 "	" "	1.57	"	22.44 "
Rye,	15.94 "	" "	1.03	"	15.98 "
Oats,	28.56 "	" "	58	"	16.52 "

The attention of legislators and political economists is especially invited to the following

SUGAR STATISTICS.

THE PRODUCT OF GOLD AND SILVER COMPARED WITH THE IMPORTATION OF SUGAR—ALSO THE UNITED STATES AND FRANCE COMPARED.

	Importation.	Home Production.	Consumption Per Head.
1831,	100,000,000 lbs.	70,000,000 lbs.	13 lbs.
1840,	300,000,000 "	120,000,000 "	25 "
1850,	440,000,000 "	230,000,000 "	29 "
1860,	665,000,000 "	230,000,000 "	30 "
1870,	1,200,000,000 "	70,000,000 "	33 "
1875,	1,700,000,000 "	120,000,000 "	43 "

The cost in gold values at the port of shipment of the sugar, syrups, molasses, &c., imported in 1871, was $86,000,000; 1872, $90,000,000; 1873, $94,000,000; 1874, $92,0000,000; and in 1875, $85,000,0000. Total for five years, $447,000,000, to which add 10 per cent. for freight and other charges to ship to this country, making the cost to us nearly $500,000,000, an average of $100,000,000 per annum, about one-fifth of our import trade.

In 1847, the gold mines of California were discovered, and the silver mines soon after. Since their discovery the amount of both mined in that region is very near $1,000,000,000. It would be natural to suppose that from such a vast sum we would have retained an ample sufficiency, for monetary purposes at least. But such is not the fact. And why? One of the prominent reasons is, during that period we have imported and consumed over $1,250,000,000 worth of sugar. A policy which allows of such results has led, and will lead to disasters and revulsions. While we have been squandering our gold for sugar, France, with a population of about the same number, by persevering in a wise policy of protection of this industry (as well as others) for the national benefit, has for the last ten years produced sufficient sugar from the beet for home consumption, and is now exporting a large surplus, and without any mines of gold or silver, possesses to-day, according to the best authorities, over $1,250,000,000 of the precious metals, $360,000,000 of which has been accumulated during the last seven years, and this after paying the unprecedented indemnity to Germany within that time.

We cannot but admire the wisdom which she possesses, by which to draw the earth's riches; and if they be desirable, which would be the best for America, that wisdom by which to control, stimulate, and regulate our industries, producing such results, or our mines of gold and silver? Are we yet prepared to accept the lesson which France has given to the peoples of the Temperate Zone on this perfected industry ready for our adoption, by which to produce our home supply of sugar, thus saving this great annual drain on our resources and giving employment to the idle laborer, now demoralized and being rapidly converted into the despised "tramp," the dread and annoyance of the country. France has pursued her favorable policy toward this industry, in opposition to the interests of her sugar-producing West India colonies. The United States has no such interest to be injured by a high protective policy; on the contrary, the same kind of legislation would influence the production of sugar from the cane in Louisiana; to increase it, stimulate and hasten the introduction of the "Beet Sugar Industry," and at the same time check the importation of foreign sugar.

Those who desire to procure further information on this subject are referred to "Beet Sugar," by E. B. Grant; also "The Manufacture of Beet Root Sugar," by Prof. Crookes, two books from which many of the statements made in this pamphlet were obtained.

SAFETY MATCHES.

The faults of the common phosphorus match are numerous and serious. The vapors evolved in their manufacture afflict the workmen with a terrible necrosis of the jawbone; children are not unfrequently poisoned by putting them in the mouth; and their liability to accidental ignition involves yearly the loss of millions of dollars' worth of property and doubtless of many human lives.

These evils are so widely known and acknowledged that we are only echoing public sentiment—educated through that most susceptible channel, the pocket—when we affirm that a substitute for the phosphorus match is greatly needed that will be not inferior to the latter in ready lighting qualities, but which shall at the same time be non-poisonous and free from liability to accidental ignition when carelessly trodden upon,

or played with by children, or carried off by rats and mice; in short, the match that is wanted should be a harmless piece of wood that will not take fire under any ordinary circumstances, except when it is wanted. The obvious necessity for such matches has called into existence several forms of safety matches which, to a great extent, meet the requirements of the case. It need not greatly surprise us that these articles have not already come into universal use, because, like every innovation, this one must go through the process of working its way gradually into popular favor, as it becomes more and more widely known. It was precisely so with the anti-sulphur (or so-called parlor) matches, which have now very largely supplanted the old phosphorus-tipped sulphur sticks with the suffocating fumes; for, although the superiority of the parlor match was obvious, its present popularity was only attained after years of competition.

The best and only real safety matches that have yet been devised contain no phosphorus in their composition, and will not take fire by friction, except upon a specially prepared surface which accompanies the box. Such matches are quite harmless should they be accidentally trodden upon, or fall into the hands of children, and are quite useless for the purpose of striking fire unless upon the chemically prepared surface before alluded to. They ignite upon this, however, with the greatest ease, and inasmuch as they combine in themselves such decided merits on the score of safety to life and property, their general introduction is greatly to be desired, and should be encouraged by every legitimate means. They are largely manufactured in Sweden, France, Germany and England. The first-named country, fully appreciating the importance of the invention, has prohibited the manufacture and use of any but the "safety match." In this country such matches are made that are affirmed to be even superior in safety qualities to the celebrated Swedish matches, and their introduction should be encouraged. W.

ANNUAL REPORT OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

IV.

We have had our attention called to a case which to us seems unaccountable. Four steam boilers, 12 feet long, five feet in diameter, $\frac{5}{8}$ iron, 52 tubes each. *No braces* and *no manhole*. These boilers are used in a charitable institution. We hope for the sake of the inmates that no accident will occur. The parties having charge of the institution have been advised respecting the matter.

An explosion occurred in November at another rolling-mill in the country, by which four persons were injured, one seriously. The boilers were constructed of $\frac{3}{8}$-inch iron; heads $\frac{9}{16}$ thick. They were 14 feet long, 5 feet in diameter, having 44 tubes each. They were constructed of C. H. No. 1 iron, and had been in use only seven months. The pressure used was 65 lbs.; safety-valve weighted to 70 lbs. The feed-water was from an adjacent river which was very foul, and it was necessary to filter it. Owing to the condition of the water, it had on several occasions lifted from the bottom of the boiler, and so far as could be ascertained this was the cause of the explosion. Boiler No. 1 broke on second sheet, just forward of seam; point marked *a* in Figs. 27 and 28 indicates beginning of fracture. The portion of the boiler represented by Fig. 27 was thrown about 200 feet, while that of Fig. 28 was thrown at least 1000 feet. The other boiler was exploded from breaking connections with boiler No. 1. The second sheet from rear end was torn out entirely, and nearly straightened. The steam-drum was carried some 1500 feet, and dropped through the roof of a dwelling-house, where it remained standing on end in the parlor. The loss by this explosion was variously estimated at from $20,000 to $25,000. The boilers were under the care of this company, and were insured.

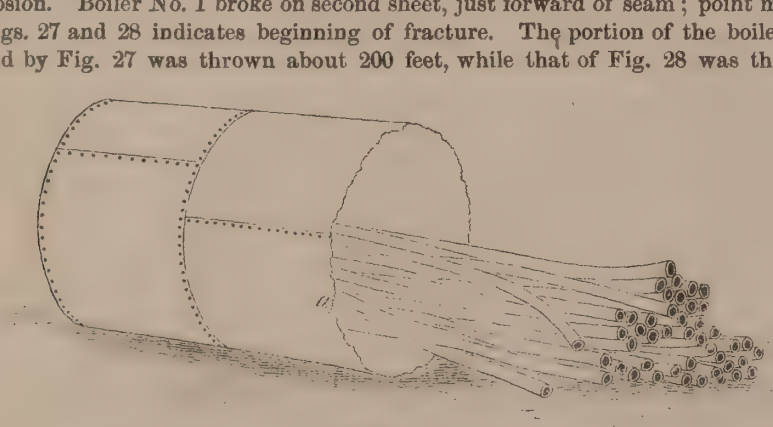


Fig 27

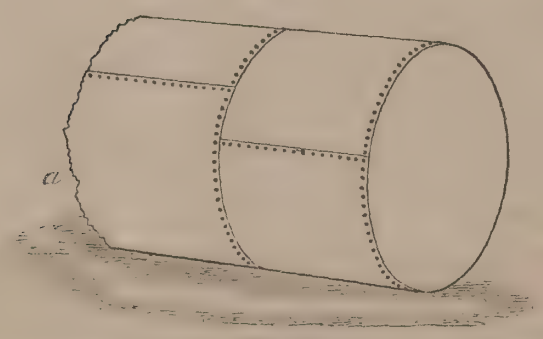


Fig. 28.

The numerous theories as to the cause of boiler explosions which have been put forth within the past ten or fifteen years are sufficient to fill several large volumes; and yet a mystery hangs over these appalling accidents, in the minds of most people. The usual verdict rendered by coroners' inquests is *low water*, and we have no doubt that some boilers do explode because the water has been low at some previous date. The theory that a red-hot boiler can be exploded by pumping cold water into it has been proved to be false again and again. Cases are on record where empty boilers have been heated *red-hot*, and the feed-water let on, without causing any explosion; but the sudden contraction of the overheated iron caused the water to pour out in streams from every seam and rivet as far up as the fire-mark extended. That a boiler in which is any considerable quantity of water and under a high pressure of steam, where some of the plates or flues are red-hot, may not be exploded by an increment

Fig. 29.

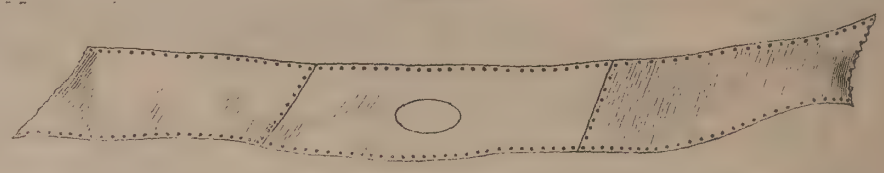


Fig. 30.

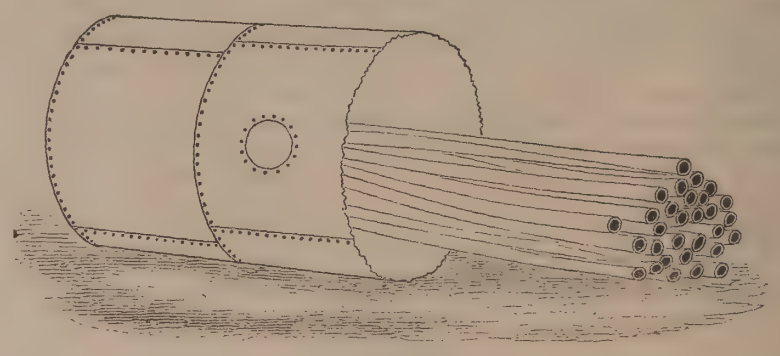


Fig. 31.

of pressure caused by the pumping of water on to the hot plates, is not doubted. It must be understood that when a boiler has been overheated to redness, its ability to withstand excessive pressures has been greatly impaired. The strength of the iron is reduced, and by unequal expansion and contraction the seams are opened, the rivets are sprung, and general weakness follows. If, after this experience, the boiler is run at high pressures, it is very liable to give out. There may be weaknesses which even comparatively low pressures would develop; therefore, every boiler in such a condition should be thoroughly overhauled before being used again. The failure to do this, no doubt, is followed in many cases by an explosion.

The reports of institutions similar to this, in Europe, have been received during the year, and by them we learn that investigations into the causes of boiler explosions are being pursued with great care and deep interest. It is a subject that should interest every steam-user in the country. The question is not, How cheap an inspection can I get, and slide along? but, How good an inspection can I secure, in order that not only my property may be protected, but also the lives of those in my employ?

There are many inducements held out to manufacturers in these days to patronize "cheap inspection and insurance." They are told that one-half or two-thirds of the money paid in will be returned. But those who understand what a thorough boiler inspection, followed up by subsequent examinations and visits, means, know that such work, performed by competent men, cannot be done for nothing.

The special agents and inspectors of the company have always manifested a lively interest in the questions discussed in this report. The original sketches of exploded boilers have been made mainly by them, on the grounds where the accidents occurred.

It is hoped that ere another year is gone the improvement in business circles will be so marked that the manufacturing interests of the country will have revived to a condition of prosperity somewhat akin to that of former years.

I remain, gentlemen,

Very respectfully yours, J. M. ALLEN, President.

HYDRAULIC FORGING.

There was a time when the smith cramped the designer by his dictum that a certain forging could not be made to sketch and scale. The introduction of the steam-hammer worked out new possibilities. Die-forging or swedging, under the screw-press or the steam-hammer, to a large extent superseded hammer work on the open anvil. But neither the slow screw-press, from its want of power, nor the fly-press or the steam-hammer, from the peculiar character of their compressing action, possessed the quality of forcing the metal, either hot or cold, accurately into the interstices of a delicate mould. The coining-press has not the required action, because it does not effect a flow, but little more than a vertical compression; the relief portions of the coin, which are most exposed to wear, being somewhat less dense than the recesses, which require no special density to resist it. The operation of coining produces no proper flow, and its action is limited to small presses and to such patterns as will "draw." But it is found that the inexorable squeeze of the hydraulic giant causes the particles of even large masses to flow smoothly and forcibly into the finest lines of the matrix, filling them perfectly, and producing the sharpest results. We may, too, obtain a power which is practically unlimited, and thus work larger masses than the heaviest steam-hammer could operate upon with any accuracy. As a matter of course, any imperfection in the slab remains in the forging; but, as a counter-advan-

tage, the fibres of the metal follow the lines of the mould—a point of peculiar advantage in cranks; and one very important point gained is that there need be less draft to the part made than a casting or a drop-forging has. Further, the slow and controllable nature of the system admits of the action being intermittent and cumulative, and of successive dies and plungers being used upon one mass of metal.

The bloom chosen must be nearly exactly the weight of the required forging; but this is quickly learned by the workman. The dies required are expensive, and duplicates must be used in rapid duplication of work, as they soon become hot. The expense is a point of special disadvantage, as in many cases ordinary forgings are made because the expense of getting up a pattern for a casting would be greater than the extra cost of forging; and the expense of the dies would be even greater than that of patterns. Still, the increasing use of the reduplication principle in machine-making largely affects this disadvantage. Iron cannot as readily be built up in particular places, by hydraulic forging, as on the anvil; still, if the surfaces are perfectly clean, an excellent weld may be obtained. It must be remembered that the need of building up is actually a marked defect in the old system; and that by the new, the amount of metal may be constrained to follow the lines of the mould, and produce irregular or reinforced castings.

There are many cases where large cranks are used, and there is no special reason for cramping them in the amount of shaft-length that they take up,—where a straight round shaft of uniform diameter may be bent (cold, if the quality of the metal permit,) to the desired throw. There is less finishing after a die forging, than where the open anvil is used. The hydraulic system is more apt than the other to remedy unsoundness or lack of uniformity from minor porosity. In one of the Haswell presses, the water is supplied at 3 tons per sq. in.—the press exerting gross pressure of 848 tons, possibly reduced to nearly 800 by cup-leather friction.

By this process may be made crossheads, outside cranks, pistons, axle boxes, wrought iron eccentrics forged in pairs in one piece, connecting rod straps, expansion links, wrought iron axle boxes, and wrought iron locomotive wheels, with the bosses formed by upsetting and welding the inner spoke-ends only—without adding any side washers to make up the thickness. It is peculiarly adapted to making eye-bars for bridge work.

In drawing down Bessemer ingots, the press squeezes them like so much putty; but there is an advantage over the work of the steam hammer, in that the ends of the ingot are convex and not concave or ragged, and the grain is finer and better, and better arranged than in impact forgings; the lines conforming in a wonderful manner to the form of the mould, winding in and out around the curves and angles, and showing in a very interesting manner the flow of the viscous metal. This property is availed of by rounding off the angles in moulds at certain points, and building them up at others; the increased excellence in the fiber more than compensating for the cutting away of the skin, and for the expense thereof.

The Edgemoor Iron Works*, near Wilmington, Delaware, have adapted the system of hydraulic forging to bridge work and kindred structures, and have designed machines with important special improvements for such work. They have also in extensive use the Tweddle system of hydraulic riveting, as arranged by Wm. Sellers & Co., and the work in process of manufacture is handled by hydraulic cranes; so that in these works the material is die-forged to shape, is riveted into structures, and handled during the process of manufacture by hydraulic power.

G.

ON FRICTION BETWEEN SURFACES AT LOW SPEEDS.

By Fleeming Jenkin, F. R. S., and J. A. Ewing.

Proceedings of the Royal Society.

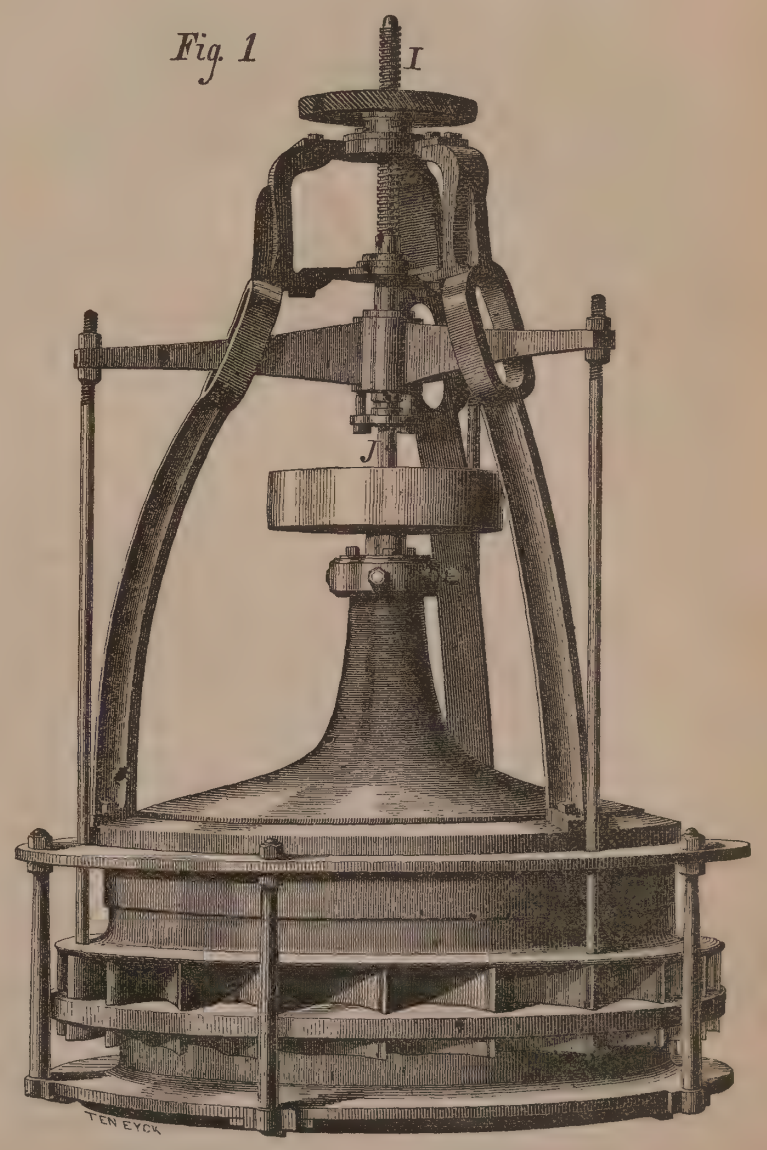
The common belief regarding friction, which is based on the researches of Coulomb and Morin, is that between surfaces in motion the friction is independent of the velocity, but that the force required to start the sliding is (in some cases at least) greater than the force required to overcome friction during motion; in other words, the static co-efficient is usually considered to be greater than the kinetic. It occurred to the authors that there might possibly be continuity between the two kinds of friction, instead of an abrupt change at the instant in which motion begins. We should thus expect that when the relative motion of the surfaces is very slow there will be a gradual increase of friction as the velocity diminishes. Whether any such increase takes place at very low speeds is left an open question by the experiments of Coulomb and Morin, whose methods did not enable definite measurements of the friction to be made when the velocity was exceedingly small. The authors have succeeded in measuring the friction between surfaces moving with as low a velocity as one five-thousandth of a foot per second, and have found that in certain cases there is decided increase in the co-efficient of friction as the velocity diminishes.

The apparatus made use of consisted of a cast-iron disk 2 feet in diameter and weighing 86.2 lbs., supported on a steel axle whose ends were less than one-tenth of an inch in diameter. These ends were supported in bearings which consisted of rectangular notches cut in pieces of the material whose friction against steel was to be measured. The disk was caused to revolve and then left to itself, when it came to rest in consequence of the friction on the ends of the axle. The rate of retardation was found as follows:—A strip of paper 2½ inches broad was stretched round the periphery of the disk, and a pendulum was caused to swing across this paper in a plane perpendicular to that of the disk. On the pendulum was fastened a fine glass siphon, one end of which dipped into a box containing ink, whilst the other stood at a short distance from the paper strip, across which it was carried as the pendulum oscillated. By keeping the ink-box strongly electrified, ink was deposited on the paper by the point of the siphon in a rapid succession of fine spots. By this means, without the introduction of any new source of friction, a permanent record was made of the resultant motion of the pendulum and the revolving disk. This frictionless method of recording was designed by Sir William Thomson for telegraphic purposes, and is employed in his siphon recorder. From the curve drawn in this way it was easy to determine the rate of retardation of the disk (and therefore the friction) corresponding to various velocities of the rubbing surfaces. The lowest velocity for which the determinations were definite was about 0.0002 foot per second, and the highest velocity to which the experiments extended was 0.01 foot per second. The surfaces examined were steel on steel, steel on brass, steel on agate, steel on beech, and steel on greenheart—in each case under the three conditions, dry, oiled, and wet with water. In the cases steel on beech oiled or wet with water, and steel on greenheart oiled or wet with water, the co-efficient of friction increased as the velocity diminished between the two limits given above, the increase amounting to about twenty per cent. of the lower value. It appeared that at the higher limit of velocity there was little further tendency to change in the co-efficient; but is impossible to say how much additional change might take place between the lower limit of the velocity and the rest. In the case of steel on agate wet with water there was a similar but much less marked increase of friction as the velocity decreased; and in the case of steel on steel oiled there was a slight and somewhat uncertain change of the opposite character—that is, a decrease of friction as the velocity decreased. This case, however, would require further examination. In all other cases the friction seemed to be perfectly constant and independent of the velocity. Out of all the sets of circumstances investigated, the only ones in which there was a large difference between the static and kinetic values of the co-efficient of friction were those in which a decided increase was observed in the kinetic value as the speed decreased. This result renders it exceedingly probable that there is continuity between the two kinds of friction.

*These Works, built upon the river Delaware, and with all the manufacturing facilities which large capital and long experience can bring to bear upon contract work upon a large scale, make a specialty of wrought iron bridges, roof trusses, wrought iron turntables, bridge pivots, and hydraulic forgings generally.

Five new cars for the steam motor line, which is to be run next month from the Brooklyn City Railroad Company's depot, corner of Twenty-fourth street and Third avenue, along the latter thoroughfare to Fort Hamilton, are now being built at an average cost of $3,100. The cars, which make no noise and no smoke, can be stopped and started with greater ease than horse cars. They will run on fifteen minutes' headway, connecting with Fort Hamilton, a distance of four miles, in twenty minutes.

Fig. 1



ADJUSTABLE TURBINE WATER WHEEL.*

"The object of the invention here illustrated, is to overcome the well-known defect of many turbines—a diminished per centage of power when used at less than full gate, by the construction of an adjustable wheel, which by a combined inner and outer gate, may, without a derangement of its assigned proportions, have its capacity varied with a like variation of the gate and chutes, according either to the power required of it, or variation of the head, without loss in co-efficient of useful effect.

Fig. 1 shows the wheel entire, with the gate partly raised; Fig. 2 a plan of the wheel; and Fig. 3 a section of the wheel with most of its top rim removed, and show-

*Invented by Silas Walton, Moorestown, N. J.

Fig. 2.

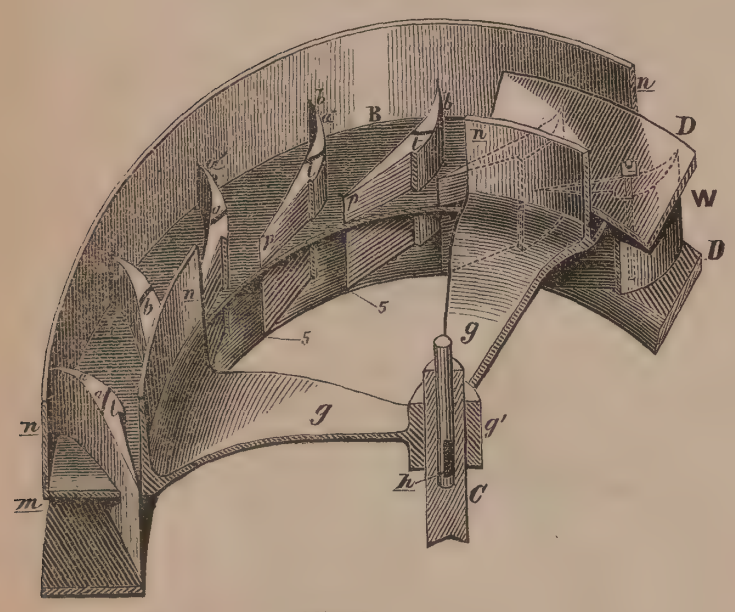


Fig. 3.

ing the inner gate (resembling a circular trough), broken away and partly open. This turbine is claimed to combine in its operation a balanced gate, to make every inch of the head of water available by the gate drawing vertically from the bottom, and to utilize the reaction (unbalanced pressure), as well the direct action and pressure of the water, by a form of bucket, made with its concavity at right angles to the impinging current, and its convex or retarding side reduced to the smallest surface, as at *a*, Fig. 2, thus to obtain not only the percussion of the water, but also the greatest pressure on the concave, while that on the opposite or retarding side of the bucket is intended to reduce to the smallest possible quantity; the curve of this part of the bucket extended, or the liquid vein when issuing from it, shall pass clear of the wall of the succeeding bucket—line 6, Fig. 2. A small recess or offset is made at this point, as seen at *t*, Fig. 2; the remaining part of the partition is a single plate, P, tapering to a thin edge. This form of bucket intercepts the further contact and resistance of the discharging current against the advancing or retarding part of the bucket, and the cross section of the outlet orifices at 5, Figs. 2 and 3, being made at right angles to the discharging current, and opposite to the curve or impinging part of the bucket, as 1, Fig. 2, the reactionary effect of the effluent should be made available. The claims of the inventor are further stated as follows:

"The resistance interposed by the wheel and its load, interrupts the current from the chutes, resulting a common pressure in the spaces of both, from the entrance of the chutes to the outlets of the wheel—s and 5, Fig. 2. Water projected against a wheel through a chute, exerts the same pressure against the opposite surface of the flume that it communicates to the wheel. The flume being immovable, the force of the water is with the current and upon the rotating wheel; and the bucket-space being a vessel under pressure, to the extent that the velocity of the mean bucket-circle of the wheel is less than that of the water due the head; the surface at 1 being made a part of the bucket and free to rotate, the reverse takes place. The pressure surface (representing the flume in the first case, being the wheel in this case), moves, and the water remains at the outlet exhausted of its force and motion; the effect being alike, whether the current be passing through the first spaces, as the chutes, or the outlet spaces of the wheel. The surface and pressure at the outlet part of the bucket, as at 5, Fig. 2, being removed, while the pressure on the opposite section at 1, remains, the unbalanced pressure gives a reaction force to the wheel whenever the velocity of the water through it is greater than that of the wheel in the opposite direction.

And having the enlargement of the discharging part of the bucket made immediately at its ultimate point of impact (the true termination of pressure surface in the turbine), as at 5, Fig. 3, gives an unobstructed and accelerated discharge from that point to common water outside the wheel.

And further, is adjustable by devices operating an outer and inner gate, which enlarge or diminish alike the chute and bucket-spaces simultaneously while the wheel is at rest or in motion, keeping it duly proportioned and the inlet current at the same angle of all times, thereby giving a full and the same per centage of power at all elevations of the gate.

The best turbine wheels being principally wheels of pressure, give the largest per centage at full gate only, and do not give a full per centage of power at partial gate, unless the bucket-spaces are diminished correspondingly with the gate and chutes, and the wheel kept as first properly proportioned. If this is not effected, no matter how perfectly the chutes may admit the water under a partial gate, if the bucket-spaces are not correspondingly lessened, expansion and a broken current takes place in the enlarged part of the bucket; the pressure from other direct action or reaction is reduced, and the wheel becomes in its operation simply a wheel of impact or percussion, which is much less efficient, as is practically shown in the loss of per centage of useful effect by the working of ordinary turbines at less then full gate, their general condition, as almost every wheel is used under a variation in either the head of water or the work to be performed."

THE TECHNICAL USES OF COBALT.

The application of ores of cobalt for blue coloring of glass apppears to have been known and practised by the ancient Greeks and Romans, since the presence of this metal has been occasionally detected in ancient glass and porcelain. The general use of cobalt ores for the manufacture of smalt did not occur until about the middle of the sizteenth century, about which time the art was practised in Saxony.

The metal cobalt was first isolated and described as a new element by the Swedish chemist Brandt, in 1733. It is closely allied to nickel in many of its properties, and its ores generally occur associated with those of the latter metal. Its chief ores are smaltine, an arsenide of cobalt, iron-nickel, some specimens of which often contain as much as 26 per cent. of cobalt, cobaltine or cobalt-glance, a sulph-arsenide of cobalt and iron, and cobalt bloom, a hydrated arsenate of cobalt. The ores of nickel invariably contain a greater or less percentage of cobalt. The preparation of pure metallic cobalt is one of the most tedious and difficult of chemical processes, and as our purpose here is simply to call attention to the practical uses of the compounds of the metal, its metallurgy need not concern us.

The metal has a reddish gray color, and is susceptible of taking a superb polish. It is less infusible than iron, but more so than gold. Like iron and nickel it is magnetic, but does not lose its magnetism by heat. Its specific gravity is about 8.5. In conducting qualities for sound, heat and electricity it is about the same as iron. It is somewhat malleable at a red heat, when free from manganese or arsenic. It is quite unaffected by air or water at ordinary temperatures, but when intensely heated it burns with a reddish flame. It is only slowly dissolved by hydrochloric acid, but nitric acid or aqua regia dissolves it readily. The solutions of cobalt salts have a fine rosy tint, easily recognizable when once seen. Cobalt has been found to make a very handsome plating upon copper, brass and iron, rivalling or even surpassing nickel in beauty. Its expense, however, precludes the possibility, at least at the present time, of competing with nickel for this purpose.

Compounds of cobalt possess the property of imparting a beautiful blue colof to glassy substances at a red heat. The important blue color known as smalt is made by fusing cobaltous oxide with siliceous sand and potassic carbonate in crucibles, and pulverizing the resulting blue glass. This substance was formerly extensively employed for the blue coloration of paper, linen, etc., but its use is now mainly limited to enameling and glazing. A very impure cobaltous oxide is made by roasting smaltine or cobaltine, mixed with siliceous sand, and comes into the market under the name of zaffre. It is also employed for the blue coloration of glass and pottery. Thenard's blue is prepared by mixing alum with a cobaltous salt, and precipitating the mixture with sodic carbonate; or by decomposing the aluminate of soda by means of cobaltous chloride. The precipitate is an intimate mixture of hydrate of alumina and hydrated oxide of cobalt. After being well washed, dried and heated, the resultant blue pigment bears a close resemblance in color to ultramarine. It is indifferent to acids, alkalies or heat, and is used for staining glass or porcelain, and for oil and water colors.

Cœruleum, another blue color, is a mixture of cobaltous stannate with stannic acid and gypsum. It is also unaffected by heat or by acids and alkalies.

Riemann's green is a compound of cobalt and zinc, made by precipitating with sodic carbonate a mixed solution of white vitriol (zinc sulphate) and a cobaltous salt. Cobalt yellow is a mixture of nitrite of cobalt and potassium, made by passing nitrous vapors through a solution of cobaltous nitrate to which potassic hydrate has been added.

A remarkable series of compounds of cobalt with ammonia have been observed and studied by Genth, Gibbs, Frémy and others.

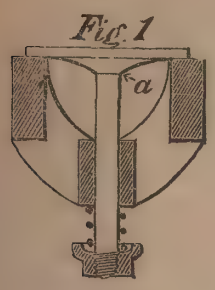
The employment of cobalt salts in the laboratory for the detection of manganese, alumina, zinc, &c., by means of the blow-pipe, is very important to the analyst. The sensitiveness of cobalt salts to heat and moisture has been utilized in the production of sympathetic inks, which are invisible at ordinary temperatures, but are rendered visible and legible on heating. For this purpose the chloride of cobalt mixed with a small quantity of gum or sugar is very well adapted. This "magic ink," as it is called, is rendered visible by holding against a heated surface. It has lately been recommended as very suitable for postal card messages, which would thus be exempt from curious inspection.

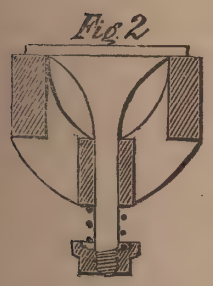
The sensitiveness of cobalt salts to moisture, which is indicated by a change from blue to a pinkish tinge, has been suggested and employed in the construction of a hygrometer or measurer of moisture. In Paris, a late scientific toy is a flower

barometer, which is simply an artificial flower of white paper which has been treated with a solution of cobaltous chloride. These flowers when exposed to the sun and dry air become deep blue, but when the air is saturated with moisture they turn of a pinkish hue, thus affording an approximate estimate of the condition of the atmosphere.

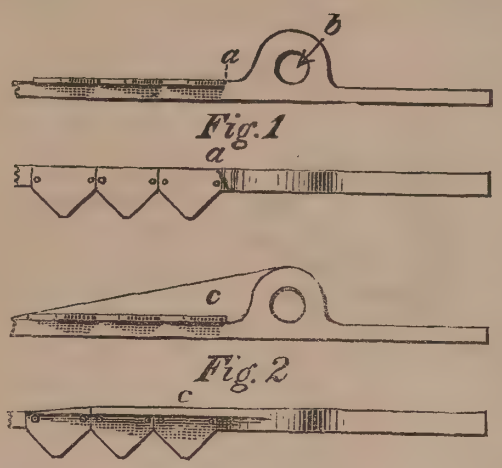
Landscapes have similarly been painted with cobalt and nickel salts, which on heating develop the characteristic shades of sky and grass.

The above facts contain in briefly-condensed form the chief features of importance presented by the metal cobalt from a technical standpoint. W.





Gas Pump Valve.



Knife Bar.

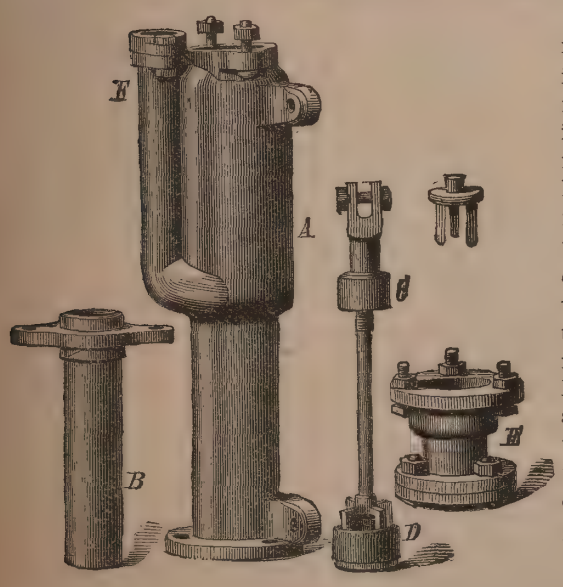
CONSTRUCTION OF DETAILS.

Some time ago I had the opportunity of observing the working of a pump used for compressing gas. The valves were of steel, and to insure their seating were pressed by small spiral springs.

The valves first used were of a shape as shown in the accompanying sketch at Fig. 1, but gave much trouble by breaking at *a*. New ones were subsequently made, as shown in Fig. 2, and these have since been working without breaking. The reason for this can only be found in the too sudden contraction or decrease from the valve to the stem in Fig. 1. There was only a very small fillet at *a;* thus the strain and shock caused by the closing of the valve was always brought to bear on the section *a*. In Fig. 2 the stem is attached to the valve by a more gradual and longer curve, hence the strain is not concentrated in one point. In knife-bars for mowers and reapers I have noticed the same condition of things.

When they were constructed as at Fig. 1, they would sometimes break at *a* after a few days' work, especially if the bolt-hole *b* had worn to any extent. I afterwards constructed them like Fig. 2, with a rib *c*, and avoiding any sharp indentation as at *a* in Fig. 1. The bolts and eyes were made of a superior iron and case-hardened; after that I never heard of a breakage, and the knife-bars would work a whole season without requiring new bolts or eyes. J. Haug, M. E.

ROBAUGH'S LITTLE GIANT PUMP.



The various parts are represented separately in the engraving. A is the outer or main cylinder, the upper portion of which is enlarged. Extending down nearly to the bottom of said enlarged part is an interior tube, B, in which works a piston, C. Attached to an extension of the rod of piston, C, is a second piston, D, which moves in the smaller portion of tube, A, both pistons operating simultaneously. In piston, D, is an upward opening valve; and in the portion, E, by which the body of the pump is connected to its supply tube, is an ordinary conical valve. F is the discharge pipe.

The water is raised by the upstroke of the lower piston, through the bottom valve, into the lower part of the main tube. Thence it passes on the down stroke, through the valve in said lower piston, into the upper part of the main tube until the same is nearly filled. Each up and down stroke forces then, by the joint action of the pistons, the water through the discharge pipe in a steady stream.

The pump has metallic valves, and its action being only a direct vertical movement, uniform wear is produced. Access to the interior is easily had, for repacking or repairs, by simply removing the bolts from the top of the pump, and lifting out the inside tube with piston, without disturbing either suction or discharge pipe. It is well adapted for windmill purposes, on account of equal pressure of the pistons on the up and down stroke. It cannot freeze up, and may be operated in either deep or shallow wells.

Patented April 21, 1874. For further particulars, Messrs. Cook & McCue, general agents, of Ottumwa, Iowa, may be addressed.—*Sci. Am.*

THE CLIMATIC INFLUENCE OF VEGETATION.

A Plea for Our Forests.

[Abstract of an article by F. L. Oswald, M. D., in *The Popular Science Monthly*, August, 1877.]

Dr. Schliemann, speaking of the Turks, says of them that "Men who for twenty generations have proved themselves tree-destroyers on principle have no right to complain if the world rises against them." But it appears that the Turks have not been the only "tree-destroyers on principle." Since the Christian era the physical history of the planet records the steady growth of a desert which made its first appearance on the dry table-land of Southern Syria, and which extended eastward down the Euphrates, and westward along both shores of the Mediterranean into France and Southern Russia. The sand-drifts of Moab have dried up the life of the world in the "cradle of civilization."

Prince de Ligne, in locating the earthly Paradise, fixes the latitude near the snow-boundary which passes through Northern Persia and Asia Minor, and reaches the meridian of Europe near the centre of the Mediterranean. The nations that once "celebrated life as a festival" have lived along this line; but such is the aridity of the soil at the present time that the struggle for existence is so hard to the vast majority of the inhabitants that life is converted from a blessing to a curse. Dr. Oswald doubts "if in the most favored regions of the New World human industry, with all the aids of modern science, will ever reunite the opportunities of happiness which nature once lavished on lands that now entail only misery on their cultivators."

Southern Spain supports now about one-tenth of its former inhabitants—Greece about one-twentieth. About one thousand years ago, after the rise of Mohammedan power, the country now known as Tripoli, separated from the Sahara by a ridge of mountains, supported a population of six millions; there are now but forty-five thousand. The climate, which is supposed to have resembled that of our Southern Alleghanies, is now so intolerable that open-air labor is not exacted, even by the most inhuman African despot, between 9 a. m. and 5 p. m. The rivers of some of these countries have shrunken to the size of their former tributaries. From Gibraltar to Samarcand the annual rainfall has decreased till failure of crops is the rule. The climate of Rome has been changed from the summer temperature of Western Virginia to the furnace heat of Mexico.

These disastrous results have been brought about by the destruction of forests. The great woodlands extending from the Pyrennes to the Himalaya have disappeared. Of the forest area of Spain and Italy, about two acres in a hundred are left; in Greece hardly one. This devastation is exceeded in the provinces; in some localities not a stick or bush can grow up but necessity plucks it. The Mediterranean, once a forest lake, is now surrounded by dusty and burning coasts, often hundreds of miles without a vestige of organic life. But even the nakedness of the most sterile tracts of Southern Europe is exceeded by the utter desolation of the Ottoman provinces.

Champollion traced on the Great Sahara desert the courses of former rivers and creeks by the depressions in the soil and the shape of the pebbles. He found tree-stumps, almost petrified, covered by a stratum of burning sand. "And so the astounding truth," he remarks, "dawns upon us that this desert may once have been a region of groves and fountains, and the abode of happy millions. Is there a more terrible crime than that of stripping our mother Earth of her sylvan covering? The hand of man has produced this desert, and, I verily believe, every other desert on the surface of this earth. . . . The burning sun of the desert is the angel with the flaming sword who stands between us and Paradise."

That the inhabitants of these districts have failed to recognize the cause of their misery implies infatuation and mental blindness. But this blindness, though not justified, is explained by the fatalism of their religion, which assumes a meddlesome Providence that rules the world in spite of man, and which produces indifference to or contempt for all the physical sciences whatever. But our own indifference to the disappearance of the forests seems much more unaccountable, since it has been demonstrated that an animal flayed or a tree stripped of its bark does not perish more surely than land deprived of its trees.

The rule of "one-third to the hunter, two-thirds to the husbandman," expresses the most desirable proportion of woodland and cultivated fields. In a country blessed with such a plethora of woods as the United States was a hundred years ago, between the Valley of the Mississippi and the Atlantic, the work of clearing could be pursued with positive benefit to the climate, inasmuch as it would counteract the excess of moisture and miasmatic tendencies. In some of the Southern and Central States this limit has already been passed. Kentucky and Michigan have a greater percentage of treeless area than a portion of Central Europe that has been settled and cultivated for upwards of a thousand years. Ohio, except the part near the great lakes, suffers from drought. In the "Blue Grass" region of Kentucky, once the pride of the West, the spring and well waters are often so sparing that the stock-farmers are moving towards the Cumberland Mountains. Wherever cotton and tobacco are cultivated the work of ruin has made rapid advances; droughts are becoming more and more frequent, and the locust, the ominous pioneer of the desert, has made its appearance.

Joseph II. of Austria was right in esteeming trees so highly as to attach penalties to the destruction of the woods on the Alpine slopes, that protect the valleys from avalanches, and proposed that in wars the trees of a country should be spared by international agreement.

The valley of Guadalquiver, in the fourteenth century, supported a population of seven millions, probably the healthiest and happiest men of Europe. Since then the live-oak and chestnut groves have disappeared, and the population has shrunk to about

one-fifth of what it then was—now sickly wretches who depend upon the scant sustenance of the barrens that are becoming sandier and drier from year to year.

The climatic influence of trees must be more generally understood before legislation can be hopefully of use. Forests perform innumerable functions which no artificial contrivance can imitate, and of which the following are the most important: Woods are the water reservoir of nature, and hold in the network of their roots and moss-carpet the moisture which is intended to supply our watercourses in the season of midsummer heat. One acre of full-grown beech trees absorbs and dispenses as much humidity as twenty of grapes and tobacco, and two hundred acres of cereals. Forests produce rain. Under the influence of vertical sun-rays trees exhale the aqueous vapor which the leaves have absorbed from the atmosphere, and in contact these vapors discharge rain-showers even in midsummer and at a great distance from the sea. By moistening the air, woodlands moderate the extremes of heat and cold. It is seen on the seashore how the humidity operates beneficently in allaying the severity of winter; and in summer the evaporation of dew and rain gives no cool breezes when the rain is most needed. The forests also, by shade in summer and in winter, protect us against the temperature. They are the home and shelter of the insectivorous birds. The locust swarms devastated the treeless expanse beyond the Mississippi, but spared the woodlands of the Alleghanies and the Pacific slope. The woodlands have an exhilarating effect upon those who visit them. Several diseases have disappeared under the disinfecting influence of the forest air. Dr. Brehm has observed this effect in cases of ophthalmia and leprosy.

This great evil is not without a remedy. Nature is always found assisting in any work of regeneration, and there is no desert so void and naked that it might not be reclaimed in a few generations. Egypt, by planting date palms and olive trees, has added many hundred square miles to her arable surface, and her annual rainfall has almost doubled. The adjoining districts also are receiving benefit. In France the Landes have been reclaimed by planting willows and bay trees; and even Algeria has been much improved by the French colonists.

But how slow is this work of restoration, and how easily might we forestall its necessity if we would begin in time! A legislative act to protect the wood of all the upper ridges in hill-countries, and of a certain percentage of acres—say fifteen in a hundred—in the plains, would be an effectual guarantee against evils which otherwise will assuredly overtake us, and more speedily than Europe, on account of the compact shape of our continent, that deprives us of the advantages of a marine climate.

B. W. P.

[Copyrighted.]

SLIDE VALVE GEARS.

By HUGO BILGRAM, M. E.

III.

The valve diagram as explained affords an easy means of studying the influence of form and motion of the valve on the distribution of steam. The most important positions of the crank, as regards the admission and the exhaust of steam, are shown in Fig. 4. When the crank is on its centre, at *K*,

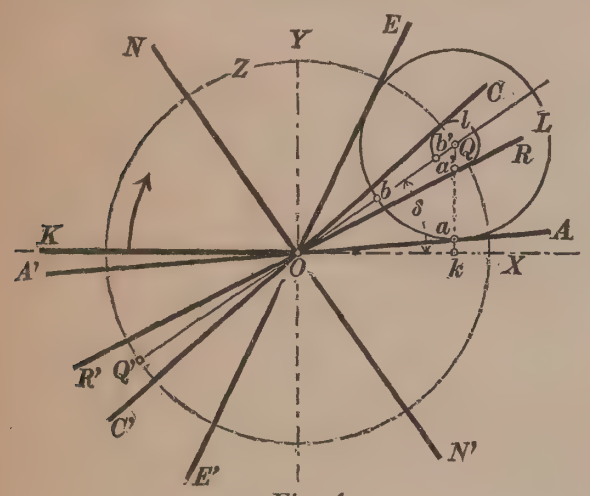


Fig. 4.

the distance *ka* shows the opening of the port for admission, or the lead on the steam side, and *ka'* represents the opening of the port for the exhaust, or the lead on the exhaust side. The valve attains its maximum movement when the crank is at *N*, forming right angles with the line *OQ*; hence the greatest port-opening for admission of steam is equal to *Ob*. This distance may be greater than the width of the steam port, showing that the outside edge of the valve overruns the inside edge of the port, allowing an unobstructed admission of steam. The word "port-opening" will be used independently of the width of the steam ports, and may therefore exceed the latter. As the crank proceeds, the port-opening will be reduced again; and when the crank arrives at *E*, the port, *S*, (Fig. 1) will be closed and the admission of steam cut off; the valve movement being equal to the outside lap. At *C* the valve movement will be equal to the inside lap, hence the port, *S'*, (Fig. 1) will be closed, and compression will commence. *OQ* is the position of the crank when the valve passes its neutral position At *R* the negative movement of the valve equals the inside lap and the port, *S*, is opened for exhaust. At *A* the port, *S'*, will be opened for admission of steam for the following stroke. For the crank-angles *N*, *E'*, *C'*, *R'*, *A'*, the results will be merely a repetition of what has already been said, with this difference only: that the ports exchange their respective functions. The lead angle for admission is shown in the diagram by the angle *A'OK* or *AOX*, and that for exhaust by the angle *R'OK* or *ROX*.

This diagram may perhaps seem, to a beginner, somewhat complicated, especially as it is necessary for some crank angles to extend the crank-line over the centre, *O*; and further, as it requires some practice to determine which of the two ports is being opened or closed. It can, however, be so drawn that the operation of the valve on each port may be represented separately, as in Fig. 5, relating to the port, *S*, (Fig. 1) and in Fig. 6, relating to the port, *S'*. By a comparison with Fig. 4, these diagrams may be readily understood without further comment. These diagrams indicate the port to which they relate to be opened, for either admission or exhaust, as long as the crank-line is outside of the respective cross-lined surface. In other words Fig. 5 may

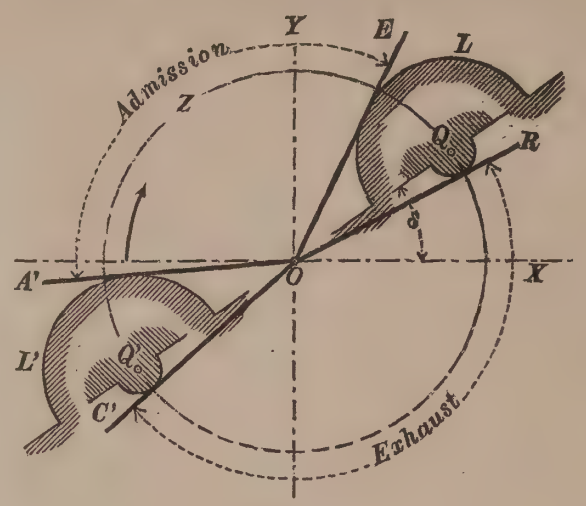


Fig. 5.

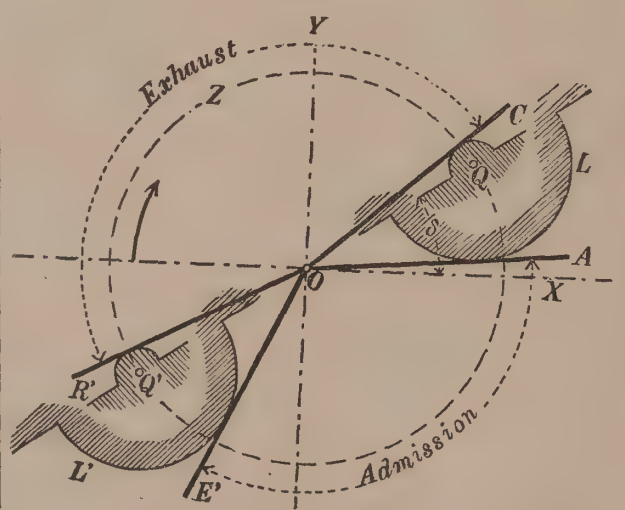


Fig. 6.

be regarded as combining two diagrams; one for admission, and the other for exhaust.

These two diagrams, Figs. 5 and 6, can readily be combined by drawing the upper half of Fig. 5 and the lower half of Fig. 6 in full lines and the rest in dotted lines. Some of the following diagrams will be executed in that manner; and it is only to be remembered that the crank-angles for cutting-off and for release (relating to the port on the steam side of the piston) will always be tangent to solid circles, while the crank-angles for compression and the beginning of admission (relating to the port on the exhaust side of the piston) will be tangent to the dotted lap circles.

When the valve possesses no inside lap, the inside lap-circle shrinks into the point, *Q*, and hence *Q* and *Q'* are the positions of the crank where the exhaust is closed for one port and at

Fig. 7.

the same time opened for the other port. Sometimes the valve may be constructed as shown in Fig. 7, possessing the converse of an inside lap. The distance, *cd*, is properly called "negative lap." Some engineers call it "inside lead," others, again, "inside clearance," but both these terms are apt to lead to confusion, for "lap" is measured when the valve is in its neutral position; "lead" is measured when the crank is on its centre; and "clearance" is the conventional name for the space left between the steam-valve and the piston at the end of its stroke. To find the opening of the port for exhaust in such a case, the distance, *cd*, must evidently be added to the movement of the valve, and hence the opening is not *ka'* (Fig. 3) but *ka''* and the diagram repre-

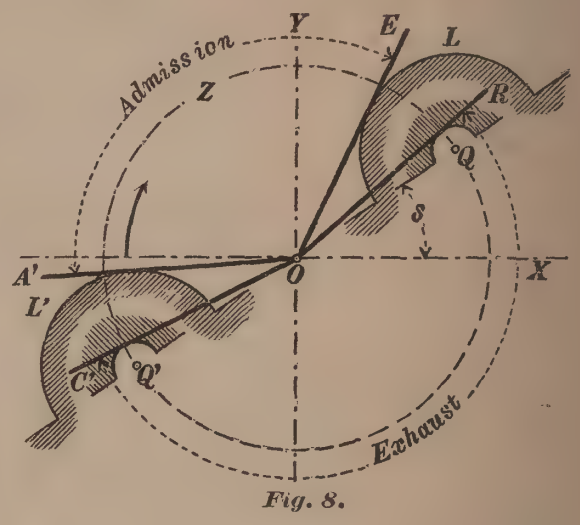


Fig. 8.

sented in Fig. 5 becomes like Fig. 8, which shows that in this case the exhaust remains opened for more than a semi-revolution of the crank shaft.

It has been stated before that the greatest port-opening of the valve sometimes exceeds the width of the port. The diagram shows without difficulty the angles for which the port remains opened to its full width. We sweep a circle, *z*, from

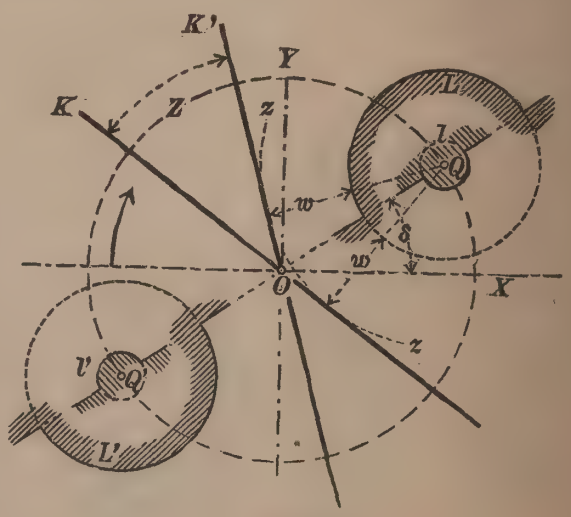


Fig. 9.

Q (Fig. 9), the distance of which from the lap circle, *L*, is equal to the width, *w*, of the port. For the two crank angles, *OK'* and *OK''*, which form tangents to this circle, the port-opening will be equal to the width of the port, and between *K'* and *K''* it will be in excess of the latter.

Or, it may happen that the greatest port-opening for admission is less than the width of the port, which then will become fully opened for the exhaust only. The greatest port-opening for admission should, however, never be less than 75 per cent. of the width of the port.

The manner of comparing the motion of the crank with that of the piston will be explained later.

(*To be continued.*)

PROGRESS IN SCIENCE AND THE ARTS.

[☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*]

ENGINEERING—CIVIL, MECHANICAL &c.

New Water Works of Detroit, Mich.—Taking advantage of a recent detention of a few hours in Detroit, Mich., we made a brief visit to the new waterworks, for further supplying that city, which are now rapidly approaching completion. These works are situated some four miles from the centre of the city, in the suburb known as Hamtramck, where the Detroit river flows from Lake St. Clair. The pumping engine was designed and built at the Detroit Locomotive Works. It is arranged as follows: A large conical hollow standard of cast iron, which forms the air vessel, carries on its upper end a walking beam, near one end of which is attached the connecting and piston rod of a vertical, high pressure steam cylinder, while at the other end is connected the piston of the low pressure cylinder, the engine being compound. From the extremity of the beam next to the high pressure cylinder the fly wheel is driven. Immediately below each of the steam cylinders is a pump cylinder double acting, with piston, taking water directly from the pits or wells in which they are situated. The passages and connections are very short and direct, so that we should look for good results. Both pumps discharge into the air vessel between them through a great number of valves, and the water is thence carried to a stand pipe by which the desired pressure on the main is secured.

The water is taken from the river through a large inlet pipe of iron which extends in a dredged trench several hundred feet from the shore to about fifteen feet of water. It was laid in sections and bolted together by a diver. The water then flows into a large, receiving basin, which was made partly by dredging and partly by enclosing the area with a double row of sheet piling, filled in with clay; the depth of water is about fifteen feet. A timber bulkhead within the basin, extending nearly across the lower end, is intended to check any current from the flow through the inlet pipe. This reservoir will act as a settling basin, if necessary, although we think that it will seldom be needed for this purpose, and will serve as a source of temporary supply in case of trouble from anchor ice. A square brick shaft at each end of the basin contains valves for shutting both the inlet pipe and the conduit to the pumps. This conduit is of brick, 5 feet in diameter, and leads to a well, 16 feet in diameter, whence a branch leads to each of two pumps pits, only one of which is at present occupied, by the engine described above.

The pit is 26 feet deep, the pump cylinders being supported on its bottom, and the bearings of the walking beam are some thirty feet above the floor of the engine room. The high pressure steam cylinder is 44″ in diameter, the low pressure one is 84″ in diameter, the two pump cylinders are 40″ diameter, and the stroke of all is six feet. The air chamber, a truncated cone, has a diameter of ten feet at the bottom and about seven feet at the top, and is made of cast iron, in segments bolted together through flanges, inside in the upper part, outside below. The eduction valves of the pumps are all grouped in four rings, around the inside circumference of this air vessel, each tier containing 58 valves, 7 inches in diameter, faced with rubber, rising and falling vertically and held in place by spiral springs. By a man-hole and interior iron ladder access can be had, when desired, to the interior of the air vessel and to these valves. The induction valves are flaps of iron, faced with leather. The pistons of both steam and pump cylinders have metallic packing rings, The walking beam is an excellent one, made of six steel plates, three on each side, with cast iron filling pieces, reamed holes and turned rivets. It is light and very strong. The fly wheel is 24 feet diameter and weighs 30 tons.

The high pressure cylinder is nearest to, and but a short distance from, the boilers, and the exhaust steam from this cylinder then passes directly across one side of the frame to the other cylinder. The condenser is placed a little on one side and is worked by a small independent engine. The steam cylinders and the exhaust pipe from one to the other will be steam jacketed, and the cylinders will be lagged with black walnut. There are four double furnaces with eight cylindrical boilers, 8 feet in diameter, containing flues below and tubes above. The chimney is octagonal, 136 feet high, with a flue of circular section, 5 feet in diameter.

The stand pipe, of wrought iron, situated near, and on the same line with, the engine house, is 127 feet high, 4½ feet in diameter at the bottom, and 2½ feet at the top. The enclosing building having a stone lower story, a brick tower, and a wooden roof, will be 180 feet high: This building was designed by J. E. Sparks, Architect, of Detroit.

The pumping house is a handsome, fire-proof structure of brick with sandstone trimmings and iron cornice, the roof being made with iron trusses, from the Detroit Bridge and Iron Company, covered with slates fastened to iron purlins by copper wire. It contains a second pit, ready for another pumping engine when needed; a second boiler house and chimney are also completed.

All of the heavy machinery was placed in position with ease by means of a temporary overhead traveller, and two winches with wire ropes.

The works have been erected under the supervision of D. Farrand Henry, C. E., the engineer of the Water Commissioners.

The Advancement made on the St. Gothard Tunnel up to May 31st, 1877.

The distance between the heads of the tunnel at Goeschenen and Airolo is 14,920 metres. These figures include 145 metres of approaches. The curved part of the tunnel at the Airolo end is 125 metres long—figures which do not appear in the table.

Designation of the Elements of Comparison.	Northern End—Goeschenen.		Southern End—Airolo.		Total progress at the end of May.
	Condition at end of April.	Monthly Progress.	Condition at end of May.		
Advanced top heading.....total length, lineal metres...	4200.0	114.0	4091.2		8405.2
Enlarged " .....in lineal metres.....	3046.6	128.3	3000.0		6174.9
Bottom heading*, ... "	2470.6	95.7	2136.0		4702.3
" enlargement, ... "	1871.7	93.3	1590.0		3555.0
Completed full area excavations..... "	1550.0	43.0	1207.0		2800.0
Arch masonry ..... "	1630.3	68,7	2115.9		3814.9
Masonry of east abutment..... "	1636.4	49.4	1097.6		2783.4
" west ..... "	1521.2	15.8	1805.5		3342.5
" invert ..... "	.....	.....	1848.0		3382.0
" the aqueduct..... "	1385.0	149.0	917.5		2451.5
Finished tunnel. ..... "	1385.0	149.0	838.0		2534.0
	1385.0	149.0	1534.0		2534.0

*This is not a heading proper, as there is no roof. It is an advance cut, similar to a heading that is driven through the bottom after the top is out.

"Eisenbahn" per *Moniteur Ind. Belge*, iv, 290.

History of Street Railway Industries.—Mr. John Stephenson, the widely-known street car builder, gives the following sketch of the early history of street railways in this country: The Fourth Avenue (Harlem) Railway was chartered as a city road in 1831. The first section opened in 1832. (See History of Railroads in the United States, by Henry V. Poor, page 224.) I can verify the statement of Mr. Poor, for I was present, having designed and built the car, "John Mason," used on the occasion. Steam, as a motive power for street cars, was used on Fourth avenue, in New York city, as early as 1835, and has continued to be used on that avenue, though of late years the outer half of the road, having four tracks, has been, and is now, used for the double purpose of "rapid transit" and the city terminus of many railways radiating east, north, and west from New York city. No other tramways were constructed until 1853, at which time the Sixth Avenue Railroad was opened, followed in 1853 by the Second and the Third, and in 1854 by the Eighth, etc. There were no tramways outside of New York until after 1855. Nor did Philadelphia have a tramway proper until about 1857, at which time tramways were also introduced into Boston. Tramways did not exist outside of the United States until 1860. George Francis Train then commenced such construction in Birkenhead, England, but no other road was made in that kingdom till 1869, and now the chief cities of Europe are enjoying this American luxury. In fact, it is an element of modern civilization adopted in Asia (Bombay and Java) in 1868, South America in 1866 (Rio de Janeiro in 1866 and Buenos Ayres in 1869, and now in every city of importance). Australia is about opening its first tramway, now nearly ready, in the city of Adelaide. It is but fair to state thal all the places referred to have tram cars of our own manufacture. The beginnings of railways in this country were for a time operated by horse power, as the Baltimore and Ohio in 1830, the Newark and Hudson in 1830, the Philadelphia and Columbia in 1834, etc., but these were not tramways, that is, street railroads. The city of New York constructed the first "tramway," and for twenty years had the only street railroad in existence.—*Railway World*, iii, 679.

Another Atlantic Cable.—The steamship Hibernia is now engaged in the attempt to raise and repair the 1865 cable, belonging to the Anglo-American Company, which has not been in operation for some years, and should this attempt be successful, as it is confidently expected that it will be, another cable will be added to those now in use at a comparatively small expense.

Experience has proved, says the *Journal of the Telegraph*, that the existing rates for Atlantic cable telegraphing are as low as can be made profitable, and any further permanent reduction cannot reasonably be expected, until the capacity of long submarine cables for the transmission of signals can be materially increased. It is in this direction that efforts should be directed, and not to the multiplication of cables.—*Sci. Am. Supp.*, vi, 1283.

A New Military Invention.—The German General Berden has devised a new distance-calculator, or, in military language, "range finder." When closed up ready for moving it looks like a sort of primitive chariot, mounted on two large light wheels and drawn by one horse. Two men ride upon the comfortable seat, the driver and the operator, and for the latter, so simple is the instrument that no special training is necessary, however desirable it may be that he should also understand the principle of trigonometrical science. When the range of any point is to be taken, before a battery begins to play, for instance, or a regiment to fire, the horse is slipped out of the shafts, and the body of the "chariot" then turned completely over on its axle. The frame on which is built the seat, then serves as a firm and steady support for the instrument. The body of the vehicle is revealed as a box or case one metre wide, nearly two long, and about a foot deep; and when its two opposite ends are thrown open, the instrument is ready for use. This consists, loosely described, of two parallel telescopes, about 1½ metres long, and very powerful, affixed to a frame which swings on a common pivot. The sight ends are just one metre apart, and this is, of course, the base line of the calculation. One of these telescopes, the one at the right hand, is movable only with the frame, of which both form a part. This is first sighted on the subject, and the frame is made fast, the first step being thus completed. The other telescope is adjustable further, on a pivot of its own, and by means of a small wheel is turned to the right angle of convergence with its companion—that is to say, until it too covers the object. Now, having the base line and the angle of convergence, any surveyor could, of course, calculate the distance. But in General Berden's instrument the wheel which adjusts the second telescope is marked off into meters, centimetres, and millimetres, is covered by a little hand or pointer, and when the object is brought within the focus the pointer indicates exactly the distance. This is absolutely all there is of it. In two minutes the instrument can be unlimbered, put into readiness, and a distance found, less time therefore than a gun or a battery is made ready. Then the two ends are closed, the body swung around into its place, the horse put into the shafts, the driver and operator mount the box, and away they dash to some other point.—*Van Nostrand's Magazine*, xvii, 187.

A New Kind of Railroad.—A new kind of railroad has been suggested by some English capitalists and engineers. The plan proposed is called "the Pioneer Railway,' and consists of a low fence of continuous girder, constructed of wood or iron, as desired, supported on edge upon posts or pillars, and surrounded by a single rail (not a single line of rails); the engine, coaches and cars running on this rail, and sitting astride of the fence, after the fashion of the panniers or packs on a camel or a mule. At any incline up to one in ten is possible, in consequence of the method of driving adopted, no expensive surveys are required, nor levels, except of the most simple kind. It is estimated that with the railway made entirely in iron the cost will not exceed $7500 per mile, including the proportion of rolling stock. By abandoning entirely the use of vertical adhesion this system is entirely independent of weight, in as far as driving power is concerned, and hence locomotive engines can be made as light as is consistent with obtaining the necessary power from them. The horizontal grip is given by mechanical appliances, which affords the means of varying the amount of pressure at will in proportion to the gradient to be traversed, and therefore to the load to be drawn. A light locomotive engine on this system means a light construction of road, but not necessarily, as in the narrow gauge systems, a seriously diminished proportion of traffic hauled by it. The weight is, as nearly as possible, uniform throughout the train, and amounts, when loaded, to from 15 to 25 cwt. per wheel.

The "Pioneer" is thus a homogeneous caravan, all the links of it being of similar weight, and the road to carry it being constructed at an outlay governed by the nature of the traffic, an in no way measured by the arbitrary weight of a conventional locomotive, whose dead weight alone would equal that of a whole "Pioneer," freight included. It possesses the very important element, from a commercial point of view, of providing a supply never in excess of the demand; freight stations and porters, passenger stations and signals, will not be required; there will be no points of crossings, derailment is impossible, and no outlay for fences, hedges, or retaining walls need be incurred, because in public and exposed places as well as for the passage of roads and rivers, the viaduct is raised to any required height. The main intention underlying the plan is to provide a mode of communication and transport which is cheap, elastic and efficient, having a low first cost, easily and rapidly erected and removed, and being capable of paying with the scattered or meagre traffic to be obtained from thinly populated and undeveloped countries.—*Eng. News.* iv, 1847.

The Refractory Properties of Asbestos, which were well known to the ancients, render it available for a variety of modern purposes. As long as it was believed to be too scarce to be of much economic importance it was but little used outside of the chemist's laboratory, and a very small quantity supplied the market. Now, however, that it has been found so useful for steam packing, fire-proof roofing, &c., a considerable demand has been created. It is found in greater or less abundance in various parts of Europe, the finest coming from Italy. The United States are, according to the *Engineer and Mining Journal*, principally supplied from Staten Island and Maryland, but it is found also in Virginia, New York, and other States. Its value in America ranges, according to quality, from 10 dols. to 60 dols., delivered. In Canada asbestos is either known or reported to occur in the following localities:—(1) East side of lake Nipigon; (2) north side of Batchawana Bay, a short distance west of the Batchawana Iron Company's location; (3) northward of Echo Lake; (4) near the Desert Lake, north of the Bruce mines; (5) township of Thorne, county of Pontiac; (6) Gatineau River, lower part; (7) Riviere Blanche, Templeton; (8) Petite Nation seigniory; (9) near Perth; (10) Second Chute, Indian River, near Peterborough; (11) township of Stukeley, Q; (12) Lot 8, in the 8th concession of Bolton; (13) Melbourne slate quarry; and (14) St. Francois, Beauce. In some of these localities the mineral is true asbestos, while in others it is either chrysolite or picrolite, fibrous varieties of serpentine, which answer the same purpose.—*The Engineer*, xliii, 447.

A Proposed New Bridge over the Thames —Mr. Henry Vignoles has designed a bridge across the Thames near the Tower. It may be termed the Mean Level Bridge. There would be three spans of 300 feet each formed of latticed girders, having a width of 60 feet, with a clear head way of 85 feet above lowwater level in the centre of the river, and 76 feet at the abutments of the bridge; thus there would be a free passage for ocean-going steamers, while sailing vessels could, with rare exceptions, pass under with the topmasts lowered. Mr. Vignoles has designed a peculiar method of overcoming the difficulties of approach, especially on the Surrey Side. There he erects a gigantic warehouse of a special design, round the sides and ends of which the approach road will rise to the level of the bridge by an easy gradient of 1 in 50. The estimated cost of the bridge, warehouse, and approaches, inclusive of purchase of property, is £600,000.

—At a meeting of the Engineering Society, King's College, London, held on Friday, June 8th, Mr. C. D. Marr read a paper "On Marine Engines." The author in commencing expressed regret at being unable, an account of the short time at his disposal, to say anything about the early history of the marine engine and the respective merits of the various kinds of propellers, and other points closely connected with the subject. He first described the various kinds of paddle engines, dwelling particularly on the oscillating engine; and spoke also of injection and condensation. He then passed on to the screw engine, and described the most recent examples of inverted and horizontal return connecting rod engines noting especially the vertical engines of the screw steamship San Francisco, belonging to the Pacific Mail Steamship Company of the United States of America, treating of the surface condensers. He next drew a comparison between the injection and surface condensers, and concluded with a few remarks on modern marine boilers. A short discussion ensued, in which several gentlemen took part. The paper was illustrated by diagrams.

—Speaking of a long tunnel in the United States, the *Baltimore Gazette* says:—Few people know how great an engineering enterprise is going on in Baltimore county. For one thing alone, a tunnel, six miles and four-fifths long—36,510ft.—is being built underground, for over four-fifths the distance through hard gneiss and granite. It will be the longest tunnel in the country, and there will be only two longer in the world, the Mont Cenis, which is eight miles in length, and the St. Gothard, now in progress of construction, and which is to be nine miles and a-quarter. The fact that the water supply tunnel lies near enough to the surface to allow of numerous shafts, greatly facilitates its construction. The tunnel is a circle, 12ft. in diameter, and extends from the Gunpowder River, about eight miles from the city, to Lake Montebello, the distributing reservoir, near the Hartford turnpike, about a mile and a half from this city, the direction being 26 deg. west of south. This tunnel will conduct the water from the Gunpowder River to Lake Montebello; thence a conduit 4120ft. long, known as the Clifton Tunnel—from the fact that it passes under a portion of the Clifton Park—conducts the water to a point just south of the Hartford-road, where it enters six mains, each 4ft. in diameter, which conveys the water to the city, a distance of 1900ft. The country along the line of the works is hilly, and the tunnel varies in depth below the surface from 67ft. to 353ft. There are fifteen shafts in the main tunnel, the deepest extending 294ft. below the surface. The water rains down the crevices of the rocks, and pours along the bottom of the drift. Gangs of men, each with his miner's lamp attached to his hat, are hard at work, picking and delving, in the flinty bowels of the earth, and the monotonous clang of the hammer upon the drill is constantly heard, except when every thing is in readiness for firing a mine, when all retire to a safe distance, and thunderous reports roll through the rocky corridors. The work of the tunnelling is all done by hand, it being cheaper than the machine-work in a drift of such narrow diameter.

MINING, METALLURGY AND MINERALOGY.

No Coal below London.—The *Athenæum* says: The boring experiment made by the Diamond Boring Company at the brewery of Messrs. Meux, in Tottenham Court-road, has resulted in disappointment, so far as the supply of water goes, but it has settled a most important geological problem. Somewhat suddenly the borer has passed from the Lower Greensand into a stratum, well marked by fossils, which Mr. R. Etheridge, the palæontologist to the Geological Survey, has pronounced to belong to the Devonian rocks. The whole of the secondary rocks below the Cretaceous system is missing. No traces of the coal measures, or of the carboniferous limestone below them, are found. Old red sandstones, upon which the Tertiary formations have been deposited, form the base of the deposits in the valley of the Thames. This settles forever the question of the existence of coal near London.

Discovery of a Gold Nugget in Nova Scotia.—A nugget of gold, for which five thousand dollars has been offered, was found in a new "diggings" at Moose River, east of Halifax, Nova Scotia. It is said to be the largest ever found in that province, and its discovery will refresh the fainting hopes of those who were in doubt whether gold mining in that district could be made to pay.

Anthracite Coal Discovery in New Brunswick.—A thirteen-foot seam of anthracite coal has been discovered at Mace's Bay, Charlotte County, New Brunswick, twenty-eight miles from St. John, the bed cropping out on the shore. It has been inspected by a New York mining engineer, and analyzed by Mr. Harrington, of the Canadian Geological Survey, who finds in it fifty-eight per cent. of fixed carbon, about five per cent. of volatile combustible matter, and thirty-seven per cent. of impurities. A company is being formed to work the property, to erect piers, etc., at an early date.—*Monetary Times.* The "Blue Noses" will have a good time marketing this anthracite in competition with Pennsylvania.—*Eng. & Min. Jour.*, xxiv, 49.

The Comstock Mines.—We take the following from the *Gold Hill News.* The Consolidated Virginia Mine is yielding from 500 to 550 tons of ore per day. The ore stopes are looking splendidly on the 1,650, 1,550. 1,500, and 1,400-foot levels. The north drift from the Gould & Curry on the 1,750-foot level has penetrated the wall of the ledge and cut the ore vein, which at that point is quite solid and fair grade ore, although not so rich as that on the 1,650-foot level further to the northward. Much trouble is experienced in running this drift, on account of the great heat caused by a heavy influx of of hot steam and vapor, created by the hot water now being drawn off in the Best & Belcher and Gould & Curry mines. The main south drift on the 1,550-foot level is being steadily enlarged, in order to create a better circulation of air. The east drift on this level cut, during the first part of the week, a fine streak of rich ore 12 feet in width. This ore is being prospected to the southward, and still appears to be as wide and rich as when first struck. Sinking the C. & C. shaft is going steadily ahead. The flow of water is still strong. The California output is from 550 to 600 tons of ore per day. The 1650-foot level is opening up rich in almost every quarter, and the double joint winze now being sunk near the south line of the mine is now down 42 feet, the entire distance having passed through rich ore. The northwest branch drift, on ihe 1650-foot level, has been finished to and connected with winze No. 4, which now affords a splendid basis for the stoping and extraction of ore from that portion of the mine whenever it is desirable to do so. The mills are all running and crushing ore up to their full capacities, and everything in and about the mine looks bright and prosperous for the future. Sinking the C. & C. shaft is making excellent progress, considering the hardness of the rock encountered at the bottom and the steady strong flow of water. The west drift from the C. & C. shaft, on the 1750-foot level, is advancing at the rate of from four to six feet per day, the face still in extremely hard blasting ground. On the 1750-foot level the north drift from the Gould & Curry has passed into the ore body. The ore is hard and solid and looks well. It assays from $20 to $59 per ton; the ore has been penetrated 9 feet, but the water of the vein has not been reached, therefore the main vein is not yet cut. The vein has been encountered farther east than expected. There is no change to report of the prospecting operations on the 1785-foot level of the Chollar Potosi Mine. Sinking the Combination shaft is going steadily ahead. It is now down 1468 feet. Daily yield, 85 tons of ore, the average assay value of which is $23 per ton. The north drift on the 1400-foot level of the Caledonia mine is being steadily advanced, the face in quartz heavily charged with pyrites of iron, which gives assays of $15 to $20 per ton of gold, the assays showing only a trace of silver. Sixty-five tons comprises the daily or yield of the Belcher mine. The face of the east drift, at the 1900-foot level, continues in quartz and porphyry; it is now in a distance of 239 feet. The south drift, at the same level, is in forty-two feet, with its face in good looking quartz. At the 1600-foot level the east crosscut from the main south drift is in 223 feet, and still running in low grade ore. Sinking the main incline progress well, although a considerable increase of water is met with. Daily yield of the Justice mine, 450 tons. The various ore producing sections are yielding and holding out finely. The drift east at the 1150-foot level is in birdseye porphyry, and driving ahead. An increase of the heavy flow of water is encountered. The header of the Sutro Tunnel continues in easy working ledge porphyry, with streaks of quartz and clay and regular Comstock formation. Very good progress is made in this material. The course of the tunnel is about 300 feet north of the Savage-Norcross-Chollar Combination shaft, and it has to go over 1200 feet in order to reach a point opposite. The miners in this shaft say that they can hear the blasts which are let off in the header of the tunnel, and the miners in the tunnel say they can hear the blasts let off in the Combination shaft. Whether this is so or not, the Sutro tunnel has certainly reached and cut into the regular Comstock ore belt, and before many months will connect with the Combination shaft, to the material advantage and benefit of both enterprises.

Tin Scrap and Tin Dust.—"In the manufacture of tinware, it is said 6 per cent. of the whole of the plates employed disappears in the form of scrap. Birmingham (England) produces 20 tons per week." A gentleman of the name of Beck, proprietor of the "Why-Not" Iron Works, in Birmingham, has had a patent for recovering the tin from scrap, for many years. He had a contract with the firm carrying on the Ettingshall Works, for seven years, to supply them with the scrap, after the tin was taken off. His contract has recently expired. It has been stated that he realized $500 per week. Mr. Beck's *modus operandi* was by solution and precipitation. A very fair trade was done by parties who went

about the tin works, buying up the tin dust. They even went to France and shipped it to England to be reduced. The so-called tin dust is what is the scum of the tin pot, and as it is mixed with grease, it is black. It contained a considerable quantity of metal, and its extraction was regarded for a time as a profound secret. The way this was reduced was by ignition and flux.—*Hardware Reporter.*

—The Mars mine, on Lake Superior, recently produced a nugget of copper weighing nine tons.

—Specimens of silver obtained near a small body of water called Sunday Lake, about forty-five miles west of the Iron river silver district of Ontonagon county, Mich., analyze $700 per ton. A small force of workmen are making further examinations.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Another New Metal has been discovered. M. Sergius Kern, of St. Petersburg, has found in platinum "ores" a new metal which appears to occupy a place midway between molybdeum and ruthenium. He is studying its physical and chemical properties, and proposes to call it Davyum, in honor of Sir Humphrey Davy. Platinum is found in the metallic state in alluvial deposits; but is rarely, if ever, pure, being generally alloyed with iron, palladium, osmium, iridium, and copper.—*Eng. Mech.*, xxv, 456.

A New Glass has lately been made with phosphate of lime, by M. Sidot. He states that it is perfectly transparent and very refringent (its index of refraction is 1·523, that of common glass being 1·525); and it can be worked like ordinary glass. It does not, like ordinary glass, dissolve all metallic oxides, but it dissolves very well oxides of cobalt and chromium. It is attacked by boiling acids, as also by potash; it is not attacked by hydrofluoric acid; and this property may render it valuable in employment of telescope glasses, for workmen who are exposed to these vapors, and who have to work in the art of engraving on glass. M. Raynaud has been experimenting on lymph as an agent of propagation of vaccinal infection. He demonstrates the virulence of lymph obtained from a vaccinated region.—*Eng. Mech.* xxv, 431.

The Work of Desolation.—Within ten years, no less than 12,000,000 acres of forest have been cut down or burned over in the United States. Much of the timber is used for fuel, twenty-five cities being on record as consuming from 5,000 acres to 10,000 acres each. Fences use up much timber, and railway sleepers require the product of 150,000 acres per annum. The amount of pine and lumber timber yet standing in the forests of the timber States is estimated at 225,000,000 feet. The sum of 144,000,000 dollars is invested in the timber industry, employing 200,000 men.

The Composition of Chinese Gongs has been found by the analysis of many specimens to be as follows:—

Copper	82·00 parts.
Tin	17·00 ,,
Iron	1·00 ,,
Nickel	traces. ,,

The last-named metal can only be discovered by operating upon several grammes of the alloy.

Chinese Gold Lacquer.—An excellent imitation of the celebrated Chinese gold lacquer may be prepared by melting two parts of shellac and one of copal, so as to form a perfect fluid mixture, and then adding two parts of hot boiled oil. The vessel is then removed from the fire, and ten parts of oil of turpentine gradually added. To improve the color an addition is made of a solution in turpentine of gum gamboge for yellow, and gum dragon for red. These are to be mixed in sufficient quantity to give the desired shade. The Chinese apparently use tin-foil to form a ground upon which lacquer varnish is made.—*Boston Jour. Chem.* xii, 5.

Spontaneous Combustion.—Strictly speaking, there is no such phenomenon as spontaneous combustion. The inflammation of various organic and inorganic substances, without the immediate contact of any ignited matter, which has given rise to the term, is, nevertheless, as certainly the result of some direct act or acts which can be accurately traced, as is the firing of a lucifer match when struck on a rough surface.

The discovery of what the active agents are, and the circumstances under which they occasion visible ignition, has long been the subject of research, and, one by one, they have been so fully investigated that there should be little difficulty in at once assigning the specific cause to every species of "spontaneous combustion." It is, nevertheless, so difficult to shake off the trammels of incorrect observation, and theory founded thereon, that there are even now many cases in which combustible substances catch fire, in spite of great precaution having been taken to prevent such catastrophes, and this because care and attention has been wholly directed to prevent something which is not likely to take place, and no thought has been given to that phenomenon upon which all combustion, as it is commonly understood, depends, *i. e.*, the combination of the components of the combustible body with oxygen.

It is not here intended to treat of fires arising from friction of machinery; lighting of explosive gases or vapors; the action of the sun's rays through unintentionally disposed lenses, such as may be formed by glass globes filled with water or knots in a pane of glass; firing of disseminated flour, or cotton, etc.; but to examine some of those cases when starting with the combustible at the ordinary temperature, it gradually becomes hotter and hotter, and at last takes fire without, to the unscientific observer, any apparent reason for its so doing.

Many animal and vegetable substances heaped together in a large mass, when neither too wet nor too dry, are liable to take fire by the heat produced by their own decomposition. Haystacks often afford examples of this. Heaps of any dry fibrous vegetable material, or of dry wool, cotton, cloth, calico, paper, sawdust, etc., when smeared with grease, oily matter, or particularly a drying oil, such as linseed, and left undisturbed in a warm dry place, are tolerably sure to be consumed by fire. Coal piled in quantity, and left too long in one place, or confined in great bulk in the hold of a ship, on a long voyage, frequently behaves in a similar way.—*C. W. Harcourt, before the Soc. of Arts.*

Nail Rod and Horse Nails.—Thus far the only nail rod which has been serviceable for iron horse nails has been the imported Swedes or Norway iron. Some progress has already been made in making Bessemer nails at home, and we learn that a new manufactory is preparing to go into operation in St. Louis for making Bessemer horse and mule shoes and horse nails. We are also happy to add that the production of a nail rod, equal in every respect to the Norway, is now a fixed fact, and nailmakers will soon have it before them for test.—*The Age of Steel*, i, 9.

Corean Paper.—Corean paper is made of the bark of the mulberry tree, and is used by the wealthier classes in Manchuria and North China instead of glass, for covering windows, for making umbrellas, &c. It resembles Japan paper. Its great strength and imperviousness to damp, and the size of the sheets, are worthy of special notice. Indeed, it is well known that the making of paper is one of the chief industries of the still isolated kingdom of Corea. It finds its way into China through the three annual fairs which are held near the boundary between the two countries. The strength of Corean paper is owing to the fact that the material is not weakened by being subjected to the action of lime for the purpose of whitening it. The paper which the Coreans use for dispatch writing it resembles, in strength and color, but it is often thicker, and it is polished on both sides.—*Paper Trade Journal.*

MISCELLANEOUS.

Auction Sale of Patent Rights.—A New York dispatch dated the 18th says: A second auction sale of patent rights took place at the salesrooms of Geo. W. Keeler, 53 & 55 Liberty street, New York. There was a full attendance from all parts of the country, and the bidding was spirited. In all 115 different inventions were put up. Several were withdrawn, but the remainder realized an aggregate of thirty thousand dollars. Among the sales were the following inventions: An improvement by means of which fruits, vegetables, berries. etc., may be preserved in their natural state an indefinite length of time, $525; combination of the rule and square, $250; invention permitting the blade to be removed from and inserted in the handle of a pocket-knife at will, $80; folding iron bedstead convertible into a table, $150; pocket-knife with detachable whetstone and saw blade, $225; improvement in brick machines, guaranteed to make 75,000 to 100,000 properly pressed brick per day, $2100; portable fire escape, with numerous approvals and a Centennial diploma, $1550; improvement in balancing the keys of pianos, $370; chemical printers' ink, which changes color if an attempt is made to alter a document, $775: chemically prepared paper, which renders writing indelible, and changes color on attempted alteration, $800; design for checks which precludes possibility of adding larger amount than that for which it was first drawn $650; invention for making hats out of wood, $350; improved rubber pad for steps, sidewalks, etc., $170; improved reversible plow, $2000; improved seed and fertilizer sower, $1250; a new game, in which soldiers are the pieces, $180; pocket folding kite for children going to the country, $500; liver and blood tonic, $170; travelers' sleeping collar, to enable persons to sleep in the ordinary seats of railway cars, $150.

Several curious and useful articles were passed or withdrawn, among them a machine for cleaning boots by wholesale; a spring attached to a music rack or piano, the touching of which turns a leaf of music instantly; a railway switch which, if left accidently open, is closed by the locomotive, making it impossible to run a train off the track; a combined traveling bag and tub; a burner for burning vapor without wick or chimney, and giving a light fully equal to coal-gas at a cost of 45 cts. per 100 feet. Another sale will be held September 3, and, possibly, monthly thereafter.

—C. J. A. Dick, of the Phosphor-Bronze Smelting Works, No. 2038 Washington avenue, Philadelphia, announces that he has ceased to conduct the Phosphor-Bronze Smelting Works business as an individual, having transferred said business to a limited partnership association, under the firm name of The Phosphor-Bronze Smelting Company, Limited. to whom all further orders or communications relating to new business should be addressed.

—The American Railway Supply Company has made an improvement in its Samson railway joint, as the result of experience. The main part or body of the bar is nine-sixteenths of an inch in thickness, with no increase at the bolt holes. The central portion, which comes at the rail joint, is seven-eighths of an inch thick. This is found to make the joint very like a continuous rail in its action, and to prevent the pounding and battering of the rail ends. The business of the company is growing rapidly. They have recently received a large order from the Philadelphia, Wilmington and Baltimore road.

—Nearly all the iron for the extensive railroad bridge across the Susquehanna at Rockville, five miles above Harrisburg, will be furnished by the Pencoyd Iron Works of Messrs. A. & P. Roberts & Co. The substantial superstructure, it is expected, will be finished by December 1st, 1877, and the aggregate weight of iron required will be about 700,000 pounds.

—A number of car wheels, intended for the Great Eastern Railway of England, have been made at the Lehigh Car Wheel Works. It has also some orders from South America.

—Pittsburgh has 73 glass factories, 33 iron rolling mills, 8 steel rolling mills, 7 white-lead factories, and 29 oil refineries, and the coal mines tributary to this market number 158.

—For the five weeks ending June 30, No. 5 furnace at Glendon made 1653 tons of iron.

—The Cambria Iron Company is erecting a new steel blooming mill of large dimensions.

—An order has been received from St. Petersburg, Russia, by the Baldwin Locomotive Works, for one of their dummies for street cars.

— The Ohio State Board of Public Works have awarded to the King Iron Bridge Company, Cleveland, the contract for building an iron bridge across the Sandusky river at Fremont for the sum of $14,755.05.

—Sample, McElroy & Co., of Keokuk, Iowa, have recently shipped one of their six-horse power semi-portable engines to be used in the new process of gold mining at the Jicarilla mines in the southern part of New Mexico.

ANSWERS TO CORRESPONDENTS.

STEAM PORT AREA. (G. R., Brooklyn.) You must not have the mean velocity of the steam exceed 80 to 100 feet per second. If A = the piston area and a the area of one steam-port, then the proportions ought to be about as follows:

Piston velocity in Feet per minute.	$\frac{a}{A}$
200	·04
300	·055
400	·07
600	·10

TO PREVENT REVERSE MOTION. (J. T., Phila.) A simple rubber ball playing in a wedge-shaped socket against the rim of your wheel will prevent reverse motion better than the noisy pawl and ratchet and be cheaper.

CASTING UNDER PRESSURE. (R. F., Trenton, N. J.) This is not only possible but actually done. When a casting is made with a long "head" there is not only the advantage of the bubbles accumulating in this head, and the metal of the head supplying deficiencies caused by shrinkage in the casting below, but the length of head causes a pressure forcing the metal into the mold lines, and doubtless somewhat compressing the texture of the casting. Sir Joseph Whitworth casts cannon, etc., under hydraulic pressure of many tons; and the explosion of a gunpowder charge has been used to force the liquid metal into the fine lines.

PLUNGERS AND PISTONS. (W. L., Wilmington, Del.) (1) A plunger generally receives the action of fluid on one face only; a piston on both; for this reason the piston is *generally* shorter. (2) The Clapp & Jones pump has a piston and not a plunger. The fact of their piston being longer than is usual gives alignment and strength and relieves the stuffing boxes from side wear, and the circumferential grooves secure lubrication. (3) A plunger may have valves in it—as in the Shand & Mason pump, in which it acts by displacement on the up stroke only, but as a valved piston on the down. (4) The "bucketplunger" pump is a misnomer.

IRON WIRE. (W. R., Saginaw.) The breaking strength of iron wire is from 85,000 to 110,000 lbs. per sq. in. Steel will run as high as 130,000 and over. But when you are using wire ropes for saw-mill carriages you can only give them a tension of 7,000 to 9,000 lbs., as being bent so rapidly around and off the drums there is extra strain. Try leather for the grooves in the drums, if you find wood fraying out.

J. de P., New York city, asks us to describe the Aneroid Barometer. This apparatus, as ordinarily constructed, consists of a cylindrical metallic box, exhausted of air, the top of which is made of thin corrugated metal, so elastic that it yields to alterations in atmospheric pressure, when the pressure increases, the top is pressed inward; when on the contrary it decreases, the elasticity of the lid, aided by a spring, tends to move it in the opposite direction. These motions are transmitted by means of delicate multiplying levers to an index on a scale. The instrument is graduated by comparing its indications under different pressures with those of an ordinary mercurial barometer. The aneroid is susceptible of great delicacy in its indications, and has the advantage of being portable. It is, however, very apt to get out of order when subjected to great variations of pressure.

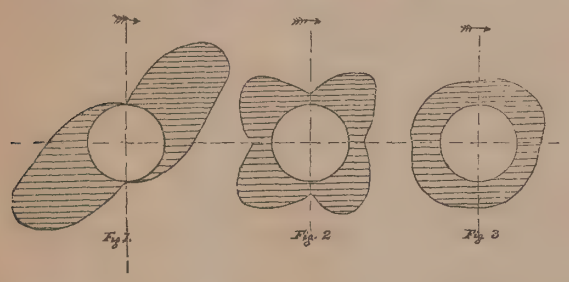
EDITORIAL CORRESPONDENCE.

EDITORS POLYTECHNIC REVIEW:—

In your reply to my communication on compound engines in your last number, you state that a diagram of the tangential rotative force of a pair of engines, coupled at 90°, even if eight-fold expansion were used in each cylinder, would not compare unfavorably with a compound engine similarly arranged. I submit 3 diagrams of rotative force; Fig. 1 of a single cylinder; Fig. 2 of double cylinders, cranks at 90°; and Fig. 3 of a compound engine, with cylinders 1 to 3, cranks at 90°, all working with six-fold expansion.

(The inequalities in the four corners are caused by obliquity of connecting rods.)

To show how much greater is the initial pressure on the



working parts of an engine expanding in *one* cylinder, I give indicator diagram of compound engine (arranged as above) in Fig. 4, and for the same expansion in one cylinder in Fig. 5. If the compound cylinders are taken as 1 to 3, two ordinary cylinders, coupled at 90°, would have each an area of 1½, to give the same power, with the same rate of expansion.

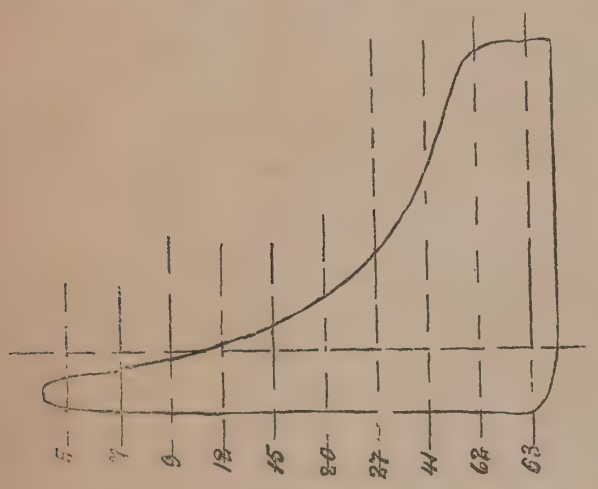


FIG. 4.

At 0.15 of the stroke the ratios of the total pressure on the working parts would stand as follows:

Compound	High pr. cyl. 1×46,	=	46
	Low pr. cyl. 3×14.5,	=	43.5
Common Engine, each cyl. 1½×62,		=	93

Thus the latter would have *twice* the strain on its working parts, which would have to be stronger in proportion, and the work of friction would correspondingly increase.

You consider one of my arguments as only against single cylinders. I do not know whether you are aware that in this country, and for marine purposes, the choice only lies between a single cylinder and a compound, as very few double-cylinder engines with cranks at 90° have been built here.

Now a single cylinder has certainly a great advantage, in its *simplicity*, and for moderate power and short trips, I would, *on that account*, prefer it to a compound; I would,

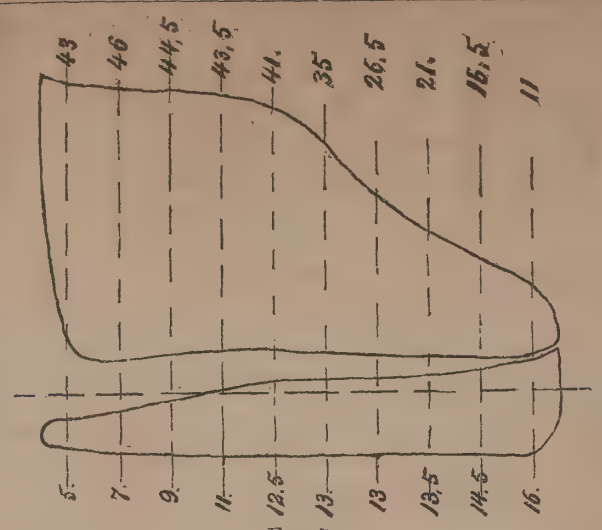


FIG. 5.

however, only use moderate pressures (30 to 40) and rates of expansion (2½ to 3).

For trips of more than one week duration, economy in fuel, *if ever so small*, not only effects a direct saving, but also a saving in boiler and bunker space and weight, adding so much carrying capacity.

With respect to engines of the Cromwell vessels, I have been informed that Messrs. Pusey Jones & Co. are not responsible for their general design. It is certain that their part of the work, as regards workmanship, construction, material, etc., has been done in the excellent manner for which that firm is justly celebrated; and *that* has certainly gone far towards mitigating the evils inseparable from the principle of great expansion in one cylinder.

For stationary engines, where a fly-wheel can balance the irregularity of tangential force, the advantage of compounding is not so marked in this respect, and a great many other conditions, besides economy in fuel, have also to be considered.

I would only draw your attention to the indisputable fact, that our most modern engines for water works are constructed on the compound principle. J. HAUG, M. E.

Phila., July 23, 1877.

[We reproduce herewith, from the Bramwell Lectures, diagrams 10 and 11 (pp. 48 and 50).

Fig. 1 shows the indicator diagram, a single cylinder working without expansion; besides in being that of the same engine cutting off at ½.

The diagrams of rotative force are shown below, the effect of the cut-off being seen in the increased tangential variation; of course, in all cases tangential force is at zero on the crank center, and at a maximum at half-stroke. Fig. 3 shows a

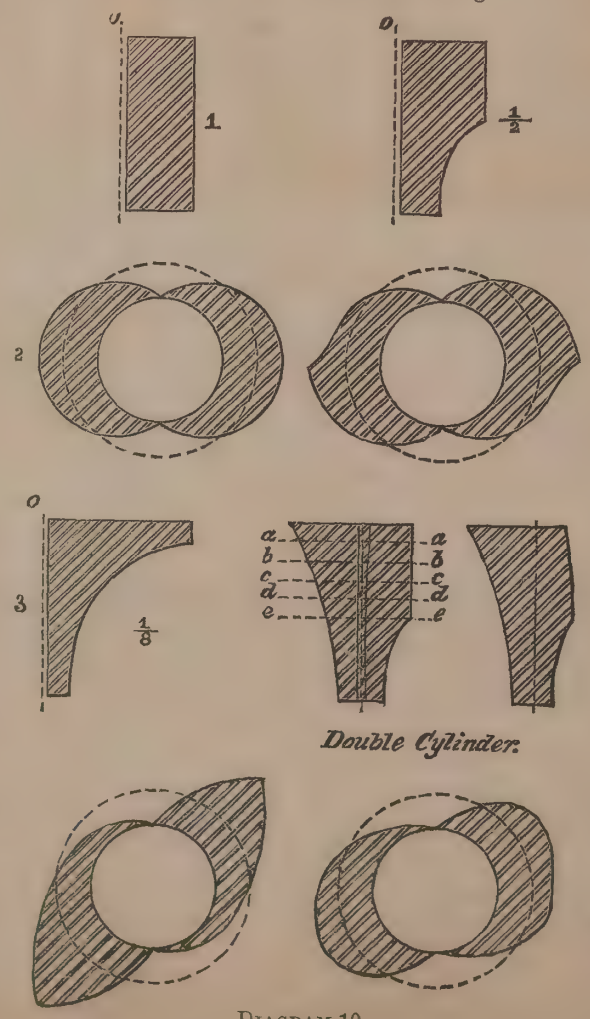


DIAGRAM 10.

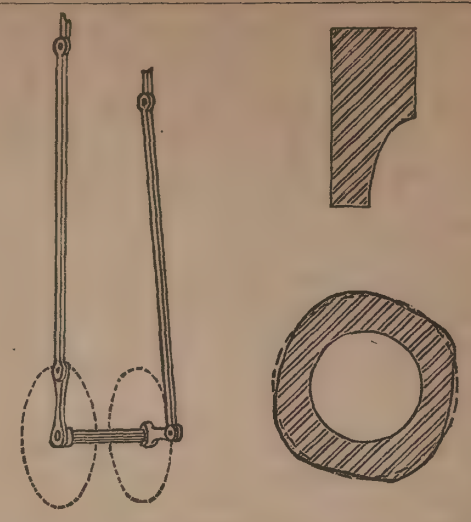


DIAGRAM 11.

single cylinder cutting off at ⅓; the increased tangential variation being seen below. Fig. 4 shows a compound engine, cylinders 1 to 4, cutting off at ⅛ in the high-pressure cylinder, and hence giving 8-fold expansion. The aggregate effective pressures of the two pistons at various points of the stroke are shown in the left hand portion of Fig. 4; below being the "rotative" diagram. (In all of these the connecting rod obliquity is disregarded.) In diagram 11 are shown two single cylinders cutting off at ⅛ and not giving such a bad showing as regards tangential steadiness, although we would have preferred Mr. Bramwell to show the two cylinders with 8-fold expansion.]

BIBLIOGRAPHICAL NOTICES.

A PRACTICAL TREATISE ON WATER-SUPPLY ENGINEERING: Relating to the Hydrology, Hydrodynamics, and Practical Construction of Water-Works in North America. With numerous Tables and Illustrations. By J. T. Fanning, C. E, Mem. Am. Soc. C. E. New York: D. Van Nostrand, 1877.

This handsome work of 619 8vo pages and 180 clear wood-engravings—all in the blackest of ink, clearest of large type, and finest of heavy tinted super-calendered paper—is a pleasure to the eye and a very creditable specimen of the printer's art. So much for appearances. In the work itself the author has done himself credit and rendered a service to the community by giving a treatise on water-supply engineering, with especial reference to American practice and demands. If it were intended for water commissioners alone, it would have a very good excuse for its appearance, and would serve admirably the purpose of comparing the merits and objectionable features of the different waters from which they often have to choose, and of affording them as well as junior engineers an excellent reference book in which to find a condensed summary of modern principles and formulas. But the work is also of interest and value to the intelligent non-official and non-professional citizen; and more than that, it gives the older practitioners, within a small compass and between one pair of covers, tables and statistics hard to hunt up and perhaps not available. An engineer about to construct a water-works, or to modify or extend an existing system, might well use the points laid down in this work as memoranda, lest he should omit some point essential in the locality in which he is to work, but which might not have been important in his previous practice.

The author's style is concise and unambiguous, and the matter thorough, widely gleaned, well put, and properly arranged.

WATER AND WATER SUPPLY. By W. H. Corfield. 144 pp., 18mo. (No. 17 of Van Nostrand's "Science Series.")

This little work is a familiar talk, in clear and concise language, by an able authority, and is taken from his lectures before the Chatham School of Military Engineering. Its illustrations are drawn mostly from European practice. The scope is more sanitary than engineering. Prof. Corfield shows that water comes into the community to be soiled, and that we need to obtain it in purity, and after use to purify or get rid of it. The tests and requirements of good water, how much is needed, and the means of getting it, are rehearsed. Prof. Corfield is a great advocate of filtering, and shows the advantages of this process applied to domestic supply. The little volume is readable and keepable.

The question of purifying or getting rid of water after using or soiling it is treated by the same writer in the next work of the "Science Series," entitled

SEWERAGE AND SEWAGE UTILIZATION. (128 pp., 18mo.) We regret very much that Dr. Corfield allows himself to endorse, or even not to condemn, the "drain-sewer," so called. All the way through, the interchangeability of the words "drain" and "sewer" is unfortunate and deserves our censure. There is nothing special in his consideration of the sewer question. The way in which, in considering the utilization question, the author demolishes, in a few trenchant words, all the precipitation and neutralization systems, except Gen. Scott's lime and clay process, is amusing.

Passing on to filtration through the soil, Dr. C. shows that upward filtration is not capable of purifying sewage, and that intermittent downward filtration affords a satisfactory means. The sewage irrigation systems are considered, and the "ridge-and-furrow" plan stated to be the best. Prof. Corfield is a strong advocate of irrigation farming.

The List of Patents is unavoidably crowded out this week.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, AUGUST 11, 1877. NO. 6.

Fig. 1.

SHOT MAKING.

Having described the manufacture of sheet lead and lead and tin-lined lead pipe, in our last issue, we next take up the process of making lead shot.

The requirements of shot are that they shall be hard enough to penetrate the game aimed at, and shall be of uniform size, perfectly spherical, and have a smooth, glossy surface, so as to meet with a minimum of resistance from the sides of the gun-barrel and from the air. Flattened or elongated shot would wabble and revolve about their shortest axes, and rough shot would score the gun-barrel and scatter in the air. Shot of varying sizes would scatter.

At first shot were made by cutting sheets of lead into small cubes and then rolling these in a rattle-box until the corners were mashed down or worn off. The invention of the present mode of pouring is ascribed to Watts, of Bristol, England, in 1782. Having dreamed that he was caught in a rain every drop of which was a lead globule, he thought of trying the experiment of pouring melted lead from such a height that the drops would harden before reaching the ordinary level, and he made the experiment successfully from the tower of the church of St. Mary, Redcliffe, realizing quite a large sum from the sale of his patent.

Shot are seldom made of pure lead alone; most commonly of an alloy containing a very small percentage of arsenic, which gives softness and ductility to the melted metal and hardness to the solidified shot. When common lead is used, the impurities antimony and iron make it hard and brittle, or rather less fluid, in pouring; in some cases as high as 1 per cent. of arsenic being needed to soften the lead. That white-powdered material which we know familiarly as "arsenic" is the teroxide, or arsenious acid, AsO_3, and not the metal itself, As. Either this trade arsenic or the bisulphuret, AsS_2 (commonly known as orpiment, and used as a depilatory, a pigment, &c.), is used to temper the lead.

Fig. 5 shows the melting-kettle. In some establishments the arsenic (which is lighter than the lead and easily decomposable), being wrapped in a paper bag, is thrust down to the bottom by a cage or basket. The top of the metal is kept covered with ashes. After some time part of the arsenic unites with the lead as an alloy and part with the litharge (PbO_2) formed by the union of the lead with the oxygen of the arsenious acid. In others, as in the one* kindly furnishing us with the accompanying illustrations, the arsenic is placed first in the pot and held down by a cover, and the lead is added above the cover, and when the lead is melted the cover is lifted off, permitting the arsenious acid to permeate the whole mass. This alloy, made in the proportions of 45 lbs. of arsenic to the ton of lead, is known as "temper," and is added in proportion of 20 lbs. to the ton; so that the shot alloy contains only about $\frac{9}{40000}$ (less than $\frac{1}{5000}$) arsenic, or about $\frac{1}{50}$ of one per cent. The temper pots hold about a ton each; and the cooled "temper," which is brown and glossy, is quite different in appearance from dull silvery pure lead. The metal is tested by dropping it in water; if there is too much arsenic, the drops will be lenticular or flattened double-convex; if there be too little, either flat or hollowed on one side, or elongated or "tailed." Strictly speaking, a different temper is needed for each size.

But we had better get up into the shot-tower—"a well turned inside out," ordinarily about 150 feet high,† and tapering from 30 to 15 feet in diameter, with inside spiral staircase around the wall, a central well being left for the pouring. Ordinarily made of brick, a shot-tower is seldom very handsome, but is quite a prominent landmark. Sometimes it is of iron, with brick filling, and the rocking is described as peculiar and not pleasant, the metal sometimes being dashed out of the pots thereby.

The melting-furnaces are built against the wall. The large cut, Fig. 1, shows one out of which two men, their hands cased in thick bag-mittens, are ladling the metal and pouring it into the "colanders." These are of iron, either flat or hemispherically cupped, and are pierced with uniform circular holes, which are smaller than the shot intended to be made, ranging from $\frac{1}{60}$ to $\frac{1}{360}$ of an inch in diameter. The pouring must be done quickly, lest the metal get chilled in the colander bottom.

* The Colwell Lead Company, New York.

† One at Villach, in Carinthia, is 249 feet high.

This is generally kept coated with a film of oxide, which is said to facilitate the pouring of round streams. The streams are, by the friction of the air, broken up into elongated drops, which by the same agent, and by the natural laws of cohesion, become spherical. That this business of filling a sieve with fluid lead is no easy task may be imagined when one is told that five tons are thrown down in half an hour.

Some establishments, instead of using the colanders, employ long ladles with straight, serrated lips, which break up the sheet into parallel streams.

Small shot get sufficiently cooled and hard by a fall of 100 feet to enable them to bear the shock of striking the water in the tank at the bottom without flattening; large ones require 150 feet.*

In 1849, Smith proposed to blow a current of air up through a tube down which the shot fell, and thus to lessen the height of tower necessary; and in 1868, Glasgow and Wood, of St. Louis, proposed to drop the lead through a column of glycerine; but we have not heard of practical results from either of these processes, nor from that one employing a horizontal table revolving with a peripheral speed of 1000 feet a minute, and in the centre of which the lead is poured, passing through a perforated brass rim and striking against a linen screen.

From the well the shot are lifted out and dried on an inclined drying-table, from which they fall into a wire-gauze cylinder, in which they are rattled to remove their minute burrs. The smoothed shot are next taken by an elevator to the screening-table (Fig. 3), which consists of a series of inclined planes of gradually decreasing

Fig. 3

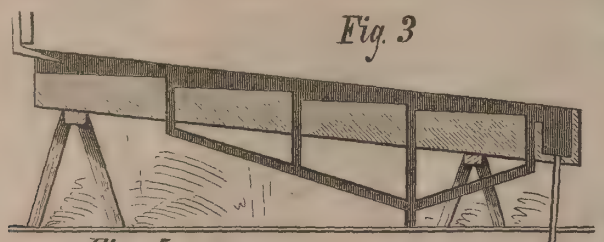


Fig. 5

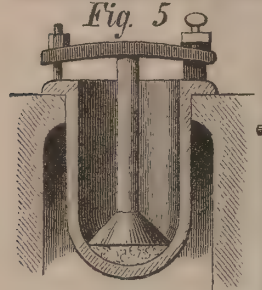


Fig. 4

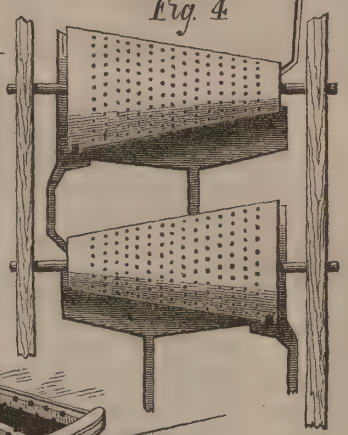
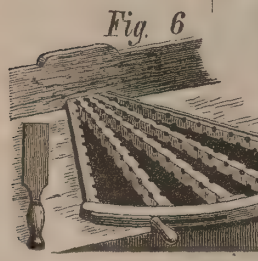


Fig. 6



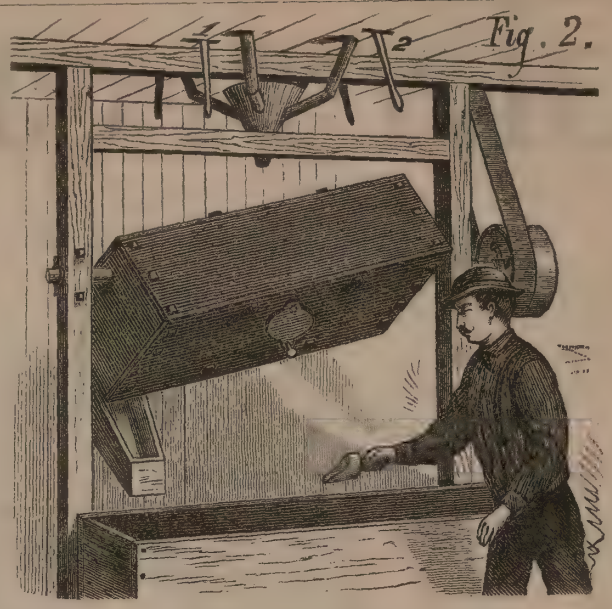
heights, with intervals between them. The shot being started at the top, those which are round and perfect will keep the middle track, jump the spaces, and make the whole trip; the uneven ones will roll off to one side or fall into the gaps, and are remelted. The round ones are next sorted to size by being run into a revolving inclined cylinder with holes gradually increasing in size towards the lower end—or into a conical frustum, as shown in Fig. 4—the smallest escaping first. Some shot-sorting devices are like a chest of drawers, being composed of sieves of varying meshes, as in cockle-separators, &c.

As regards sizes, these are standard with each maker. The Colwell Lead Company has a smallest size, known as "dust;" then comes No. 12, .05 inch diameter, 2326 to the ounce; and by increasing hundredths up to .23 inch, with only 24 to the ounce.†

Estimating the diameter of the earth as 7912 miles, No. 12 Colwell shot has but $\frac{1}{7912 \times 5280 \times 12 \times 20} = \frac{1}{9{,}786{,}086{,}400}$ that diameter, and only $\frac{1}{(9{,}786{,}086{,}400)^3} = \frac{1}{937{,}188{,}902{,}339{,}470{,}140{,}653{,}244{,}000{,}000}$ the volume.

Being sorted, the next thing in order is polishing, which is done by putting in a rattle-box (Fig. 2) with plumbago and rotating this rapidly, giving the smooth, glossy

Fig. 2.



black and frictionless surface required. Weighing and tying up in bags come last.

Fig. 6 shows a machine for moulding buckshot, in sizes ranging from .22 to .38 inch. There is a series of pivoted bars, the upper edges hollowed so as to form half moulds, which, when the bars are together, make the complete spherical cavities. Of course such shot require only rounding and polishing to be ready for market.

G.

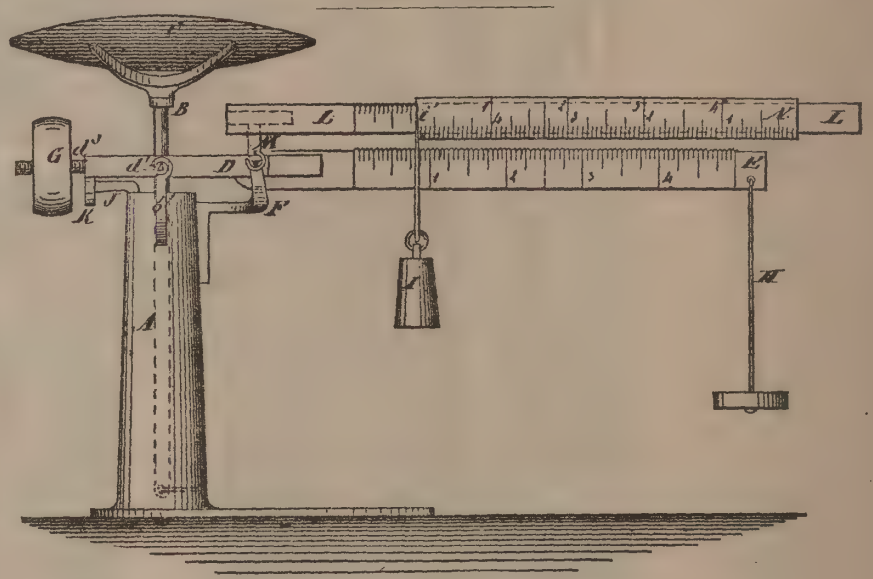
* Buckshot and bullets are made either by casting or by compression in dies; in this latter case the metal being fed in in the form of a rope or coil.

† The following tables illustrate some Baltimore and New York usages:

BALTIMORE.				NEW YORK.			
Sizes.	To oz.	Sizes.	To oz.	Sizes.	To oz.	Sizes.	To oz.
TTTT	22	4	115	FF	24	4	132
TTT	26	5	140	F	27	5	168
TT	30	6	180	TT	31	6	218
T	34	7	225	T	36	7	291
BBB	39	8	365	BBB	42	8	399
BB	45	9	610	BB	50	9	568
B	53	10	1130	B	59	10	848
1	60	11	2200	1	71	11	1346
2	77	12	3200	2	86	12	2326
3	94			3	106		

Haswell gives (without stating manufacturer)—

Size AA.....	40 to oz.	Size 3.....	135 to oz.	Size 8.....	600 to oz.
" A.....	50 "	" 4.....	177 "	" 9.....	984 "
" BB.....	58 "	" 5.....	218 "	" 10.....	1736 "
" B.....	75 "	" 6.....	280 "	" 11.....	2140 "
" 1.....	82 "	" 7	341 "	" 12.....	3150 "
" 2.....	112 "				



IMPROVEMENT IN BEAM-SCALES.

[Patented October, 10th, 1876, by George W. Grove, of Linnville, Ohio.]

The engraving is a side view of a beam-scales, to which this improvement has been applied.

The object is to furnish an improved attachment for beam-scales for determining net weight when gross is weighed, and also for dividing weights, as in stock-scales.

A is the hollow pedestal. *B* is the holder for the pan, *C*. Upon the opposite sides of the standard of the pan-holder, *B*, are formed arms, *b'*, which are curved downward and upward, and have eyes formed in their upper ends to receive the knife-edges, d^1, formed upon the side bars of the frame, *D*, to which the beam, *E*, is attached. To the sides of the forward part of the frame, *D*, are attached knife-edges, which rest in eyes formed in the ends of the arms, *F*, formed upon or rigidly attached to the pedestal, *A*. Upon a screw, d^3, attached to the rear end of the frame, *D*, is screwed the balancing weight, *G*. To the forward end of the beam, *E*, is attached the rod, *H*, to receive the weights when heavy articles are to be weighed. The beam, *E*, is provided with a scale of division marks, and has a pea or counterpoise-weight, *I*, in the usual way. *J* is an arm attached to the rear side of the top of the pedestal, *A*, to enter a loop, *K*, attached to the rear part of the frame, *D*, to limit the play of the beam, *E*. *L* is a beam placed parallel with and a little higher than the beam, *E*, and the rear or inner end of which is attached to an arm, *M*, attached to one of the arms, *F*, or to the pedestal, *A*, so that the beam, *L*, may be stationary and rigid. The beam, *L*, is provided with a scale of division marks corresponding exactly with the marks upon the beam, *E*. Upon the stationary beam, *L*, is placed a sliding bar, *N*, upon which is formed a scale of division marks corresponding exactly with those upon the beams, *E L*, but numbered from both ends. The bar, *N*, is provided with points at its end to enter the notches in the upper edge of the beam, *L*, to prevent the said bar from slipping when adjusted.

When the tare is to be weighed first, as, for instance, in retailing butter, the vessel is weighed first, the bar, *N*, is moved outward until its inner end corresponds with the pointer, *i'*, of the link of the counterpoise-weight, *I*. The butter is then put in, and is balanced by adjusting the weight, I, and the net weight of the butter will be read from the bar, *N*, opposite the pointer, *i'*. If the gross weight is to be obtained first, the article and its package are weighed, and the sliding bar, *N*, is moved inward until its outer end corresponds with the pointer, *i'*. The article is then taken out of the packake, the package is weighed, and the net weight is read from the bar, *N*, opposite the pointer, *i'*, counting from the outer end of said bar. This bar, being figured from both ends, will weigh on and off, as the case may be, and being an adjustable slide instead of a removable plate, should count up any number of pounds by adding or subtracting the extra weights, as is done in common scales.

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January 10th, 1877.

RIVETING.

The simplest fastening for malleable metal plates is the rivet, which is in effect a bolt, with head, body and nut in one, or a bolt with two heads. It differs in use from the bolt only in that the latter is generally used with the stress parallel to the axis, and in these cases is in tension, while the stress on a rivet is generally placed at right angles to its length, so that it is in shear. Many of the rivets used by bridge builders are subjected to a tensile stress, while turned bolts are intended to resist shearing stress mainly.

The rivet in its general form is of round rod, with the tail* forged cup-shaped or otherwise, the shank being cylindrical in that portion which passes through the plates, and slightly tapered beyond that. It is essential that the tail (or first formed head), where not countersunk, have its flange formed perfectly at right angles with the shank, and that it be concentric with the latter. Countersunk rivets are, for many reasons, the best; and oval sections of shanks, although but seldom used, are preferred to circular, when the holes are punched.

Possibly the best shape has a truncated cone interposed between the body and the head, filling a countersink made for the purpose. This permits the height and weight of the flat heads to be reduced; and if the heads should break off, there is the countersink to hold the plates with considerable force.

The material for the rivet, if for iron or soft steel plates, is generally of soft uniform iron, hot pressed into dies. Very good soft rivets may be set up cold; but generally the rivets are heated to a red heat, placed in the holes in the plates to be connected, and the head formed by either hand or machine. In the first case the head is formed by two men with hammers, and frequently finished by the aid of a die or "snap." In machine riveting there are two dies used, pressed together by steam or hydraulic pressure. Steel rivets have been used, but they suffer so much by heating that good iron produces as good or better results, and hence is employed even for steel plates (thus sacrificing some of the advantages gained by the use of the stronger plate).

Steel rivets have been unsatisfactory, as requiring more evenness in heating and greater speed in setting up. Hammering below red is bad, as it tempers the metal at the point of impact, and makes of the rivets a series of zones of different conditions, some having great resistance and little capability for extension, and some the reverse. It is probable that machine-riveting would largely remedy these defects.

Riveting by power was first accomplished in machines actuated by cranks or cams, giving a uniform amount of traverse to the die, so that rivets of varying length or diameter were driven into holes of varying diameters, with a uniform amount of compressive motion; sometimes failing to fill the space for want of metal, sometimes overstraining all the joints from excess of metal in the rivet.

Steam riveting superseded the old "Bull machine," and better work was accomplished at the expense of considerable wear and tear from the shock of the blow so readily given in the use of direct-acting steam pressure.

Hydraulic riveting-machines, properly arranged, afford advantages over all the other systems, inasmuch as a uniform steady pressure can be obtained, free from shock or blow, causing the metal to flow into the holes and to fill them perfectly, insuring within reasonable limits the same pressure on each rivet, regardless of the length or size of the rivet or the diameter of the hole into which it is to be forced.

Mr. Ralph H. Tweddell, of Westminster, S. W. Great Britain, has invented and extensively introduced abroad a system of hydraulic riveting which is said to combine all the advantages and to avoid the difficulties incident to previous machine systems. His system has been introduced into this country by Messrs. William Sellers & Co., of Philadelphia, who control the invention in America, and who have modified it to some extent in adapting it to the wants of the trades using it here.

The Tweddell system is applicable to either stationary or portable machines, the plant requisite consisting of a hydraulic pump and an accumulator, the latter made with detachable weights so as to be readily adjusted to any requisite weight or pressure per square inch. Thus, when driving either a large or a small rivet, the pressure can be set to what has been demonstrated is needful to do the work well and without straining the sheets.

This pump and adjustable accumulator may be connected by hydraulic pipes to either stationary or portable riveting-machines, and various useful riveting devices that have been contrived to compass special work. We give in Fig. 1 a cut of the adjustable accumulator and pump.

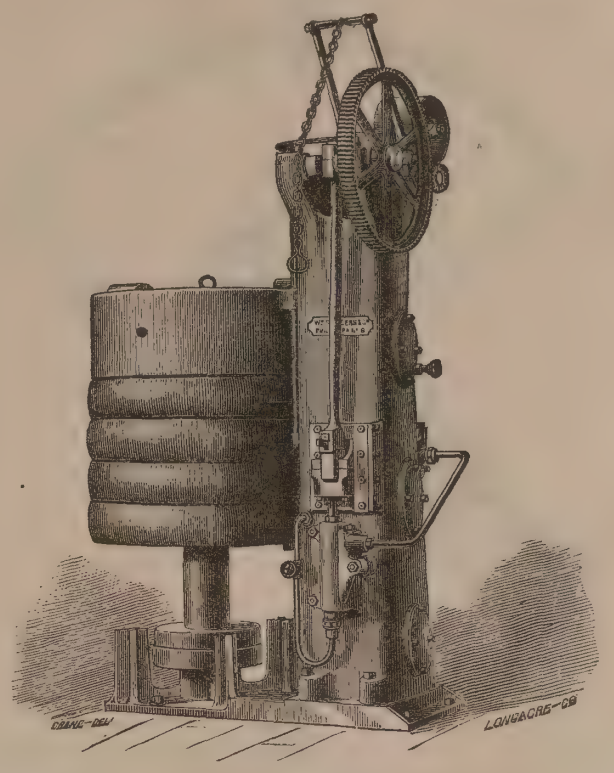


Fig. 1.

The stationary hydraulic riveter differs but little from the steam riveter save in size of the cylinder. A steam riveter for ordinary boiler work has usually a cylinder of 30 to 36 inches diameter; some have 60 inches. The cylinder of the hydraulic machine is only 6 inches diameter. The wonderful convenience of the hydraulic system is manifested in the portable machine, of which we give illustrations, in three positions, in Figs. 2, 3, and 4, showing how it may be adjusted to act readily on seams oblique, horizontal, or vertical. Fig. 2 shows the shape of the riveting-jaws or levers. The rivet is driven by the dies in

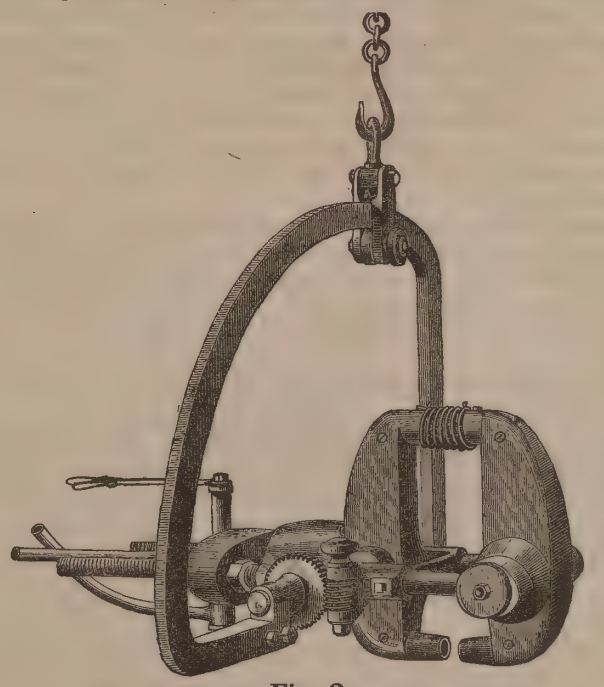


Fig. 2.

short ends of levers. These levers or jaws are made of various lengths, suited to different work. In all cases the proportion of the two ends is as two is to one. Thus they are made with lever 6 inches and 12 inches long, 9 inches and 18 inches, or 12 inches and 24 inches.

The portable riveter is suspended from a hoisting-machine on an overhead carriage, this carriage having a longitudinal motion on overhead rails, of in some cases 50 feet, and a transverse motion of 6 feet; thus permitting the use of the machine at any point within a space of 50 feet by 6 feet wide. In this space the work rests on trestles, and the riveting-machine is moved along or around it. One man raises and lowers the riveter, adjusts it to the rivets, and then closes the dies on the rivets. Boys drop the red-hot rivets into place, with the head of the rivet uppermost in horizontal work. With a skillful operator, as many as six to ten red-hot rivets may be put in place ahead of him, and he can, on beam work, drive from ten to sixteen rivets per minute.

As regards the formation of the holes, we may either punch or drill them. The first process is open to the objections that the spacing is apt to be inaccurate, and the metal immediately around the holes is injured by the compression and the tearing across of the fibres. This latter evil is not very great in plates of the best soft ductile iron—at least if the punch be sharp and the hole in the die-block be not too large. But with steel or cold short iron plates the weakening amounts to 15 to 30 per cent., the metal being strained beyond the limit of elasticity, and rendered unhomogeneous and incapable of equal stretching under stress. This marked evil necessitates the annealing of steel plates after punching, or else

*The name "tail," as applied to that enlargement of the shank of a rivet which is made with the rivet, is found on few price-lists, being generally called the "head;" that enlargement which is "set up" when the rivet is in place being called the head also. We prefer to make a distinction, and in using the word tail we follow good authority and our own early usage.

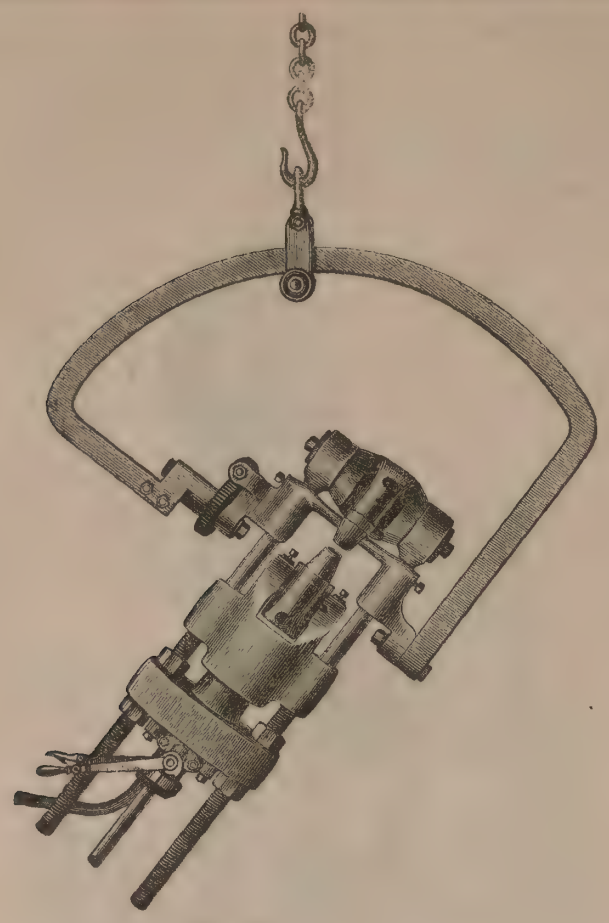


Fig. 3

the punching of holes smaller than the rivet and reaming them out to the desired size. The chief advocate of punching is Fairbairn, his main argument being that it tests the quality of the metal! It is certain that the worst iron would tear with punching, and would be rejected; but moderately poor iron would *not* show this, and would be further weakened by the punch.

Drilling, if properly done, ensures, more nearly than the average punching, accurate size and spacing of the holes; and where sectional girders or columns are to be riveted together, gang-drills are used to great advantage. But a *properly constructed* punching-machine will make the hole wherever the punch strikes the iron; punches with square ends not being apt to "lead" or "run," as the common flat drill will do. The plate being properly placed under either a punch or a common drill, may be more accurately pierced by the punch than by such drill. The punch working faster than the drill, in hand-placing the plates there is more carelessness with irresponsible workmen. Good workmen can punch any amount of work without needing the drift to aid in assembling. An objection to drilled holes is that their edges are apt to be sharp and to act unfavorably to the shearing resistance of the rivet. Sir W. Fairbairn showed that slightly rounding the edges of a drilled hole increased the strength of the joint about 12 per cent.; rounding punched holes strengthened the joint only $2\frac{3}{4}$ per cent.

Punched holes have one advantage over parallel drilled holes, in that they are generally tapered, and, if put together with the small diameters adjacent, give a clinch in the body of the rivet itself. But drilled holes may be made tapering as well as punched ones can.

The plan of multiple punching enabled the use of punching for girders, &c., where the distance of the holes was fixed, and there was a great number of pieces to be punched to standard distances.

Some shops gain clearance by grinding away the punch so that it is "reverse taper;" this gives straight holes, but decreases the strength of the punch.

It is in some cases desirable that the punches be of very slightly different lengths, so as to act in succession like the successive portions of a shearing-knife, to avoid excessive strain upon the machine. But where thin iron, as for screens, is to be punched, close-fitting punches may be employed, and these should not enter the die any further than is necessary to do the work. Small holes in thick iron require short punches, and any considerable amount of "lead" in a gang involves an element of weakness on account of the extra length. Gang-punching-machines for bridge work and the like are made of very short stroke and powerful enough to drive all the punches at once. The "spiral punch" enables a much larger hole to be punched in a given machine than with a flat punch. In punching very large holes through thin plates, on existing machines, the capacity is increased by the equivalent device of corrugating the end of the punch.

Where punching is used, the metal should be at least "hand-warm," torn parts be rejected, and bad-fitting holes be *reamed* down (*not drifted*). The use of the cutting-drift

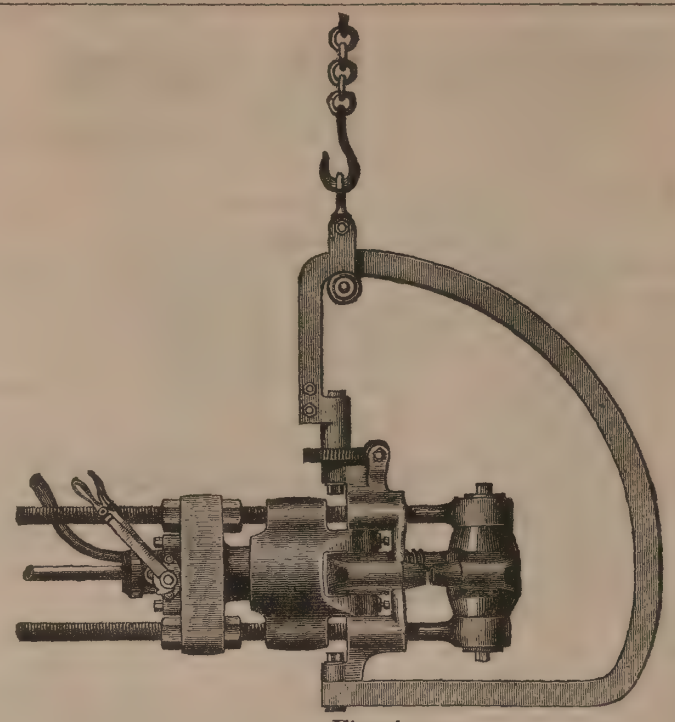


Fig. 4.

is often an exaggeration of the evils of bad cold punching; and the use of the straining-drift is an abomination and a shame.

In using red-hot rivets, the lengthwise contraction of the shank draws the plates together, tightening the joints between the surfaces of the plates, and between the plates and the head and tail-faces; but it causes tension on the rivet, and with very long shanks, this increases so much that it endangers tearing, and hence the tail part is not heated, or is cooled before putting in place. This drawing causes also a frictional resistance to sliding between the plates, enabling the joint to sustain considerable stress, even when the rivet is too small.

In machine-riveting both heads are generally heated. A tension of 21,000 lbs. per square inch of rivet section would secure a friction of at least 7000 lbs. per square inch of its section. (In estimating the strength of riveted joints, this element is neglected because uncertain, and because gradual elongation of the rivet lessens or annuls it.)

To secure "staunchness" or tightness of riveted joints, there should be a minimum safe distance between the rivets and between them and the edge of the plates. If the holes be too near the plate-edge, the latter is apt to burst in punching; if the holes be too close together a crack extends between them. For punched holes the edge distances apart or from the plate-edge should not be less than the diameter.

When a joint is *not* staunch, it may be made so by caulking—that is, burring down a narrow strip at the edge of the plate, and around the tail and heads of the rivets. The edged caulking-tool generally used causes very little useful compression and contact, and, in fact, scores or grooves the lower plate, and renders it liable to fracture along the score-line. A round-nosed tool, on the contrary, produces a wide strip of contacting surface and increased tightness, and does not score the plate.

As regards the strength of riveted joints, we may first consider a single-riveted lap joint in tension. The joint may give out, (1) by tearing of the plate between the holes; (2) by crushing the sides of the rivet or hole, or both; (3) by the plate breaking across in front of the rivet; or (4) by shearing of the rivet. To get the best theoretically perfect joint, these chances should be made about equal by properly proportioning the diameter of the rivets and the distances from the plate-edge and between the rivets to the thickness of the plate; the holes must be well filled, the plates well drawn together, and the longitudinal tension on the shanks not too great. The plates should be planed and beveled, and the edges caulked with a round-nosed tool, if at all.

As regards these proportions, we will not discuss or even tabulate them here, but will merely say that elliptical rivets could be used to marked advantage, and are the only ones satisfying the conditions of equal bearing, tearing and shearing resistance.

Hot riveting has the advantage of drawing the plates close together, and thus increasing their frictional resistance and staunchness between the plates; and the disadvantages that poorer rivets may be used, that with long rivets there is too much lengthwise tension brought to bear, and withal the contraction of a red-hot rivet does not permit of its filling the hole when cool; this diminishes the staunchness between plate and rivet, allows leakage and corrosion, facilitates play in the joint, and lessens the bearing surface and consequent shearing resistance. Machine-riveting, while it has sometimes a tendency to form the heads eccentric, exerts a resistless pressure upon the fibres of the rivet, and causes the shanks to have full contact with the sides of the hole, the plate surfaces to be pressed well together over large areas, and the head and tail to bed themselves well down to the plates. The work is handsomer than hand-work, and more regular, the heads being better shaped and more dense. Of course the greatly increased speed and cheapness of machine-work is well worth being taken into consideration.

G.

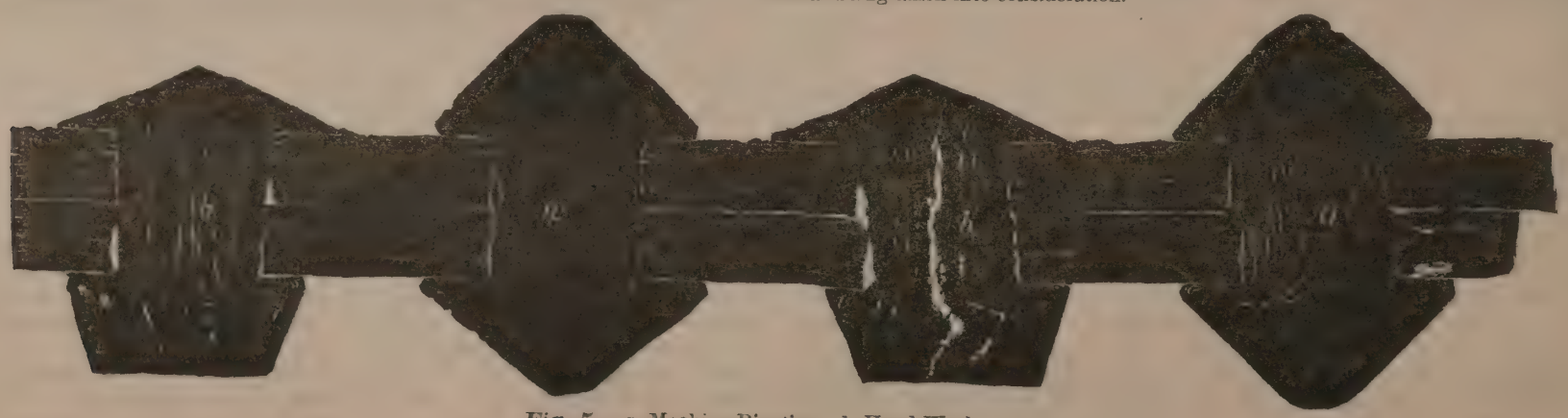
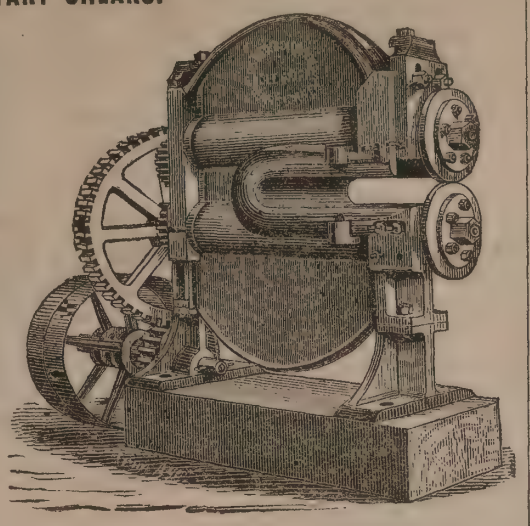


Fig. 5.—a, Machine Riveting; *b*, Hand Work.

ROTARY SHEARS.



We illustrate herewith a pair of rotary shears for cutting and trimming iron and other metal plates, and made by R. S. Newbold & Son, Norristown, Pa. The machine works with both rapidity and accuracy. The cutters are 12″ diam., giving a cut of 3′ at each revolution, and when working flue or sheet iron not over ¼″ thick, the speed is from 40 to 50 revolutions per minute, which is equivalent to 120′ to 150′ of well-trimmed iron in that time. For iron from ¼″ to ½″ thick, 30 to 35 revolutions is a better speed, and when it is desired, the gear wheels are so arranged, by having two sizes, as to give different speeds for light and heavy work. When the work is to be very heavy a small vertical engine is attached to the frame and used for driving the shears. The operation of the machine is very simple. In front of the cutters is placed a cast iron tramway, planed true, and on this travels a wrought iron carriage with turned wheels and flanges, and the sheet to be trimmed is placed upon the carriage, the front end going under two wrought knees, and the back end of plate being firmly held to carriage by a pair of tongs. The trimmer has only to push the carriage forward until the plate enters the cutter, when the latter draws it through as fast as a man will walk at a brisk gait.

For circular work, a clamp frame is made which can be readily put on or taken off, as the case may be. This clamp has two adjustable centres for holding the plate securely while the cutters trim it in a few seconds to a perfect circle with smooth edges.

For slitting skelp iron, an adjustable gauge is put in the throat of the frame inside the cutters; the strip being compressed between the cutters and the gauge, is cut perfectly uniform.

J. C.

SAW MAKING.

The manufacture of saws, from the plain hand-saw to the immense circular and gang saw, has been brought to such perfection by the firm of H. Disston & Sons, in this city, that a description of the process as carried on in their establishment, at Front and Laurel streets, might be of interest.

Their raw material consists of "blister bars," which are blistered from a particularly pure brand of Swedish iron.

These bars, together with steel scraps, are melted in crucibles; furnaces used for this purpose are of the ordinary construction. The melted steel is poured into moulds, and the ingots are forged out into blooms under a heavy steam-hammer.

In hammering, as well as in rolling, great care has to be exercised to obtain uniformity of density and tension, otherwise the hardness and temper could not become uniform, and there would be a tendency to buckling and consequent heating.

These blooms are brought under a train of rolls, similar to those used in plate mills, and, after having been re-heated several times, at last acquire the necessary thickness and width. It is of course important to make the saw blade as thin as can be for its work, so as to effect a saving in first cost, in the lumber to be cut, and in the power for cutting. (As a good sawyer can cut with a thinner saw than a poor one, it is but questionable economy to employ green hands.) After being annealed they pass to the trimming shears, where the ragged edges and all other superfluous material is removed, and they are then ready for teeth cutting.

The big coarse teeth of the larger circular and gang saws are cut out by punches; some of them are driven by power and resemble an ordinary punching machine, the punches and dies being formed according to the shape desired for the teeth. A number of hand presses are also used for some particular kind of work.

The machine for cutting the teeth of hand saws consists of a rapidly revolving disk, into which a steel cutter of proper shape is inserted. In front of it are four friction rollers, which take the steel blade between them and propel it past the revolving cutters at such speed that the proper pitch of teeth is attained. For small hand saws, with very fine teeth, a number of hand lever presses are still used, although they work much slower, and at greater expense, than the above power machine.

The angle and frequency of teeth must be adapted to the work to be performed, and consequently differ greatly; but a general rule is that they should be a uniform distance apart and all of equal length. Clearance or chamber space is required in large saws, to hold the sawdust until it can escape, and in some gang saws a special deeper clearance space is arranged after every second or third tooth. Soft wood, requiring greater feed, thus also necessitates more clearance. With large teeth the clearance space or gullet should have rounded outlines, to prevent cracks from starting, as they frequently do in sharp corners.

Another important point in shaping teeth is to adopt a form that will allow the greatest amount of sharpening (and refiling) with the least expenditure of material, labor, files and time, and diminish, in circular saws, their diameter, in gang saws their width, by the least possible amount, so that they can be used for a longer time with the same efficiency.

Messrs. Disston & Sons have adopted and patented a system for shaping teeth, in conformity with the above conditions, and their saws have lines marked on them, to serve as guides for sharpening and adjustment.

The saws now go to the hardening and tempering room where they are heated in ordinary reverberatory furnaces, and then plunged into an oil bath, which makes them hard and brittle as glass; sometimes they are also distorted and twisted out of shape. All this is to be corrected in the tempering furnace, to which they are now taken.

The tempering furnace is built around a hydraulic press, the head of the plunger being surrounded by the flames; this head is of such size as to take in the largest circular saw. When such a one, or a number of smaller saw blades are placed upon it, the pressure is put on, it rises slowly, and at last presses the saw blades against the top p'ate of the press, and holds them until the necessary temper is given. When the blades come out they are straight and surprisingly flexible. They are generally tested by being forcibly bent nearly double, and if any one should crack, or not return to its original straightness, it is rejected.

The principal requisites in hardening and tempering are that the metal be hard enough to cut well and to remain keen, while not so hard as to crack, to prevent swedging or to resist filing. It should also have sufficient stiffness, without brittleness, so as to permit setting.

The saws now go to the hammering benches, where they are placed upon iron straightening blocks and treated with peculiar hammers. These hammers have long narrow faces at both ends, parallel to each other, but at 45° to the direction of the handle; it will thus be seen that the marks made by one face will be at right angles to those made by the other, so that the hammerer can place his marks in almost any direction without changing his position.

This hammering process requires great skill, so as not to produce deep hammer marks, or create any unequal strains that might cause buckling.

The saws are now ready for grinding; some of peculiar shape, especially those that require a thicker cutting edge, are ground on ordinary grindstones by being pressed against them by the grinder. This is of course a very slow process and must be a terrible strain on the workmen.

There are several very ingenious grinding machines in use; in those for circular saws, a bed is placed across the face of the grindstone. A frame sliding on this bed contains a pivot pin, on which the circular saw is slowly revolving, and this is effected by two friction rollers (also attached to the sliding frame), which take the edge of the saw between them.

Opposite the grinding face of the stone the saw is supported by a set of rollers, and thus it is ground while it is slowly revolving, and moved along on the sliding bed. In another machine the saw moves between two grindstones opposite each other, and thus the two faces are ground at the same time. In another machine, destined for large gang saws, two grindstones are also used, one above the other, while the saw is slowly dragged between them horizontally.

Common hand saws are ground on a machine with *one* stone, the saw blades being placed in an arched block connected by arms with a swing shaft in front of the stone.

The arc of this block is described from the centre of the swing shaft, at the same time forming a tangent to the stone; the block, after the saw is put in being moved up and down, will insure a uniform thickness of blade.

After being ground the saws go into the polishing department; a rapidly revolving pulley, encircled by a leather belt, on which emery is glued, is the means by which small saws are polished. On some of these pulleys the emery is not glued on, but the article to be ground is wetted, dipped in emery, and then held to the polishing wheel. The circular saws are fixed on a shaft, which is then revolved at great speed, and a polishing block with emery is pressed against them.

In grinding and polishing, great care has to be taken to obtain a uniform thickness and a smooth surface, so as to reduce friction in sawing.

After being polished the hand saws go through the blocking process, that is, they are hammered on a block of hard wood, whereby any buckle or twist is taken entirely out.

Undergoing all these different treatments, the saws have become a little too loose and flexible, and it becomes necessary to give them a certain stiffness, which is done by heating them in a small reverberatory furnace until they attain a violet or blue hue. When they come out they are wiped with diluted muriatic acid, which takes off any color, leaving them bright and shining as before. The acid is removed by immersing them in lime water, and they are then put into saw-dust, which takes up all the moisture.

The grinding and polishing has still left some cross marks and irregular lines on the surface of the saw; to give them a smooth appearance with a uniform stroke of polish they are subjected to the *rubbing* process. A box, running on slides, is reciprocated by a connecting rod from a rapidly revolving crank-shaft; into this box the saw is put, covered with polishing powder, and a block fixed to a lever, which can be raised and lowered, is pressed hard down on it while the box is reciprocating; when taken out, the blade has a beautiful gloss, and a regular and uniform stroke of polish.

The saws are now taken to the work benches, where their teeth are set by hand with a small hammer; they are then put, two and two together, in a vise and filed, so as to give their cutting edges the proper bevel.

The teeth of large circular and gang saws are beveled by a machine with an emery wheel having a rim in accordance with the shape of the teeth.

The hand saws are now ready to have their handles put on; the necessary holes are punched, the blade is put into the slit of the wooden handle, and a number of brass screws are put in and tightened up by counter-sunk nuts. The saws are then again overhauled on the block and any little irregularity corrected by hammering.

They are now taken down to the storeroom, where they are again overhauled, cleaned and packed into packages, which are properly labeled and put into their proper places.

In the sample room of Messrs. Disston & Sons', their magnificent glass case exhibit, shown at the Centennial Exhibition, can still be seen. Innumerable drawers and closets contain samples of all the different saws and other tools manufactured by the firm, and their systematic arrangement clearly shows the spirit that pervades the entire management.

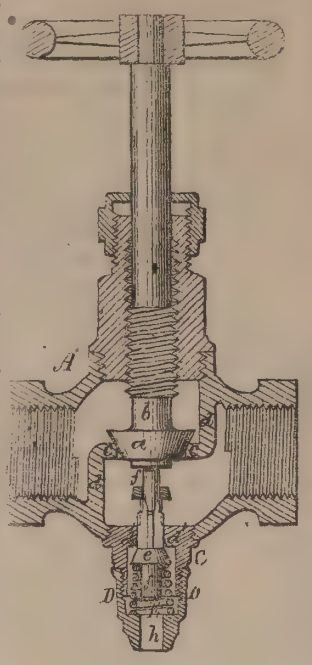
The transportation of materials, etc., throughout this entire establishment is effected by means of small cars running on a railway of about 16 in. gauge; communication with the different floors of the building is kept up by several elevators.

To give an idea of the extent of these works, it may be stated that 1200 workmen are employed, and about 40 tons of new steel used up per week.

J. HAUG, M. E.

IMPROVED GLOBE VALVE.

We herewith illustrate an improved globe valve*, the object of which is to permit the outlet of any water that may be left in the pipe after the head of water is shut off by the closure of the main valve. The invention consists essentially of an ordinary globe valve, to the base of which, and diametrically opposite to the main valve, is attached a casing, *D*, in which a valve, *e*, is placed, which is held to its place by a tapering helical spring circumscribing its stem, *f* (the stem being much reduced in size above the valve, *e*,) the upper end of which is in contact with the prolongation of the stem, *b*, of the main valve.



When the valve, *a*, is open, the pressure upon the internal end of the valve stem, *e*, is relieved and the spring forces the valve, *e*, to its seat, the stiffness of the spring being such as to overcome the internal pressure of the water in the pipe. When the main valve, *a*, is closed, its sub-stem, *f*, forces the valve, *e*, from its seat and thus allows any water that may remain upon the waste side of the valve to flow out. The improvement is intended to be applied to the waste-supply or induction pipe of a building. On closure of the main valve, the waste-educt valve is opened and allows the escape of the waste as before explained, and consequently preventing the service-pipes being burst by the freezing of the water which would otherwise remain in them.

THE LATHE CHUCK.

Every workman who has had any experience in a jobbing or repairing machine shop knows the make-shifts that are necessary to chuck work to the lathe spindle, in the absence of a comprehensive chuck that shall act as a simultaneously moving jaw chuck, and one of independent jaws. In a manufactory of regular articles, where one day's work is but a repetition of that of the day preceding, special chucks may be economically employed, but in a shop for general work it is a very desirable thing to have a chuck that may be readily adapted to any common job. To meet this requirement a chuck should be at will either concentric or eccentric, and be changed from the one to the other quickly and easily, and without being removed from the lathe spindle. In short, to sum up the requisites of a theoretically and practically perfect lathe chuck, these conditions should be fulfilled: The chuck should be light and yet strong, easily handled, positive in the movement of the jaws, holding articles firmly in position, having no uncovered slots to admit dirt and chips to the parts, be either a concentric or eccentric chuck (scroll or independent jaw), and when changed to the latter be made to move its eccentrically-placed jaws simultaneously; and finally these changes should be made while the chuck is on the spindle of the lathe. These requirements are so exacting that it would seem to be almost impossible to combine in one tool such varying, if not opposing, movements. But there is reason to believe that the result desired has been accomplished, a judging practical man will soon have an opportunity of rejecting or confirming, as arrangements are in progress for the manufacture of this combined chuck on a scale commensurate with the demands of the trade. A few nine-inch and twelve-inch chucks have been made and are in use, giving good satisfaction. Engraved illustrations would facilitate description, but an idea may be obtained from the following:

The chuck in general appearance resembles the ordinary scroll or concentric chuck, and carries either three or four jaws. These jaws slide in radial slots on the face, and are made of such a length that at every point, from centre to circumference, in which they may be, they cover the slots entirely, thereby excluding all dirt and chips. The jaws have three shoulders, or steps, the outer or upper one, of course, much higher than the others, and when the jaws are reversed, as may be done in less than one minute, these long outer steps become the lower or centre ones, holding securely any small body as the shank of a drill or reamer. That portion of the jaws which projects into the body of the chuck is cut into a half-nut that engages with a screw, the square head of which projects through the face or rim of the chuck to receive a wrench. Below this projecting head is a bevel pinion, inside the rim, that engages with a circular rack or toothed ring. Now it is evident that turning any one of these screws will actuate the rack and every other screw, and so far there is nothing new nor peculiar in the chuck; it is simply a concentric-jawed chuck. But the peculiarity of the chuck is its ease of transformation into one with eccentrically-placed jaws. The geared ring rests upon a plain ring, the periphery of which is a screw thread, or a partial thread, that engages with a similar thread on the inside of the shell, so that by turning the ring in one direction it is moved forward towards the face of the chuck, and by turning it the other way it is carried toward the back of the chuck. It is evident that by this means the circular rack may be meshed in gear with the pinions on the screw, or disengaged from them. When in gear the ring is held in position by a spring catch. Should it be required to move one or more of the jaws further than the others from the centre, the spring catch is released by thumb pressure, the supporting ring turned by a pin in a slot at the back of the chuck and the circular rack unmeshed. Then the jaws, one or more, may be moved singly into the position required, when the circular rack and the screw pinions may be again meshed, forming a chuck with eccentrically-placed but simultaneously-moving jaws, an element of convenience appreciable by every machinist. When we add to these features of merit the fact that the chuck is light—one of twelve inches in diameter weighing only about thirty pounds—that the jaws, screws, pinions, circular rack, and supporting ring are of steel; that the jaw screws and the pinions are of one piece, and that the chuck may be entirely dismembered by removing three slot-headed screws while the chuck is either on the lathe spindle or the bench, it would seem that the desideratum of a practically perfect chuck is nearly attained. These chucks will be made of all sizes, from nine inches to thirty-six inches, soon as patterns and special tools can be prepared, when they will be probably illustrated in these columns. The inventor is Mr. A. F. Cushman, of Hartford, Conn., a well-known manufacturer of drill chucks. Should the chuck, when introduced, bear out in extended use the promise of the trials thus far made, Mr. Cushman will have earned the gratitude of many a bothered and harassed workman, and deserved the pecuniary reward which will probably follow.

J. H. L.

*Patented by Earnest Hœhn, of Lawrence, Mass.

AN ADDRESS DELIVERED BEFORE THE MECHANICAL ENGINEERING ASSOCIATION OF CORNELL UNIVERSITY,

BY PROF. JOHN E. SWEET.

What I have to say during the half hour I hope to interest you this afternoon, I do not wish you to consider as a lesson from a teacher to his pupils, or a lecture from a professor to his students, but as a collection of thoughts from one who has travelled partially over the road that now lies before you; one who has hit against many of the mile stones by the way, and splintered off a fragment here and there; one who has left, he hopes, a mark or two upon others, as well as received some, if not his full share of bruises, scratches, and scars in return; and one who has learned some lessons which he trusts will, if well set before you, enable you to profit by his experience. Your mechanical education, or the lessons you learn from the literature of Mechanical Engineering are but the thoughts of other people, or a record of their experiments and history of the experience of those who have gone before. If I picture to you my thoughts, give you the result of my experiments, and illustrate the successes and failures of my experience, that, too, will constitute a part of your education,—infinitely small, perhaps, compared to the whole, but none the less a part because of its being gained in the work-shop instead of the lecture room. So, too, with your own experience. That you will find is an important part of your education, and the better record you keep of it the more you will contribute to your own advancement as well as to the advancement of those who follow.

Our successes and failures.—An expose of the failures would be the best lesson of the two, and could we have the history of all men's failures side by side with their successes literature would be squared, if not cubed, in extent, and were it not for the overwhelming magnitude of the collection, doubled or quadrupled in value. While practical men have a goodly number of failures to answer for, science cannot boast of all the successes. Failures can be pointed out by the hundreds, where, by a little knowledge of the simplest mechanical principles, they might have been avoided. Scores upon scores of the most flagrant failures can be traced to men of the highest scientific pretensions, not that they have possessed too much science—no one can—but because they lacked experience or good judgment, which is acquired to a great extent by experience. The mechanical and engineering establishments of the country can be benefited, and greatly benefited, by the employment of men possessing a higher standard of scientific knowledge; and it will be your duty and your opportunity, when you go from here to try, in a quiet way, to use and disseminate such of the scientific knowledge you acquired here as you are masters of. If we believe that science attains its highest mission when it develops useful results; if we believe that theories are best taught by practical lessons; if we believe that principles are best explained when embodied in material forms; then in an institution like our own university, where a greater part of your time is occupied in studying books, considering science, and absorbing theory; where you live upon food that has to run the gauntlet through the quadrangle of laboratories, quenching your thirst with water that has performed its full amount of useful work, and breathe air which struggles to escape mathematical entanglement; living in a climate where history is rained down like November storms, and among a people who, if they spoke the language they profess, would make our home a modern Babel, the energy expended in forcing in practical lessons cannot be all useless, if it in any manner tends to lessen the number of graduates, who, in years to come, say, as many can be found who now say, "I feel that my college education so far as turning it to practical account is concerned, has been half thrown away."

If we advocate the employment of more brain work in our manufactures and more hand work in our schools, let us not overlook the fact that brain work and hand work, that theory and practice, always have been and always will be occasionally at variance. Neither let us forget that it is not always the theory, nor is it always the practice that is at fault—for sometimes it is the one and sometimes the other, and not unfrequently both.

In theorizing it is very easy to leave out one or more of the elements or factors in the problem, or rather it is very difficult to think of all the elements even in an apparently simple mechanical problem. While in practice it is not at all unfrequently that we profess to carry out the theory or the plan to the letter, and yet fall far short of it—declaring the theory wrong when in fact it is the practice which is wrong.

To illustrate the first of these statements I will give a case of my own experience. You are all probably conversant with the ordinary method of making cut nails. The blanks are sheared from the end of a strip of nail plate whose width equals the length of the blank. The blanks are cut tapering by holding the plate at an angle with the shear blades, and they are cut alternately, heads and points, by turning the plate over after each cut. Although a vast amount of money has been expended in devising and building apparatus for turning and feeding the nail plates to the nail machine, probably one-half of all the nails cut at the present time are fed by hand. Some twenty or more years ago my brother and myself conceived the idea that by using a punch and die for cutting the blanks, instead of shear blades, making the punch exactly of the form of the blank, and punching out one blank just the right distance from the end of the bar, so that the piece cut off should be the size and shape of another blank, that we could thereby make two blanks at one and the same operation, and also avoid the necessity of turning the plate—and farther, that we could by feeding the plate to the punch in a vertical direction, cutting the blanks from the lower end make the machine self-feeding without mechanism. Two happy thoughts all must admit, and as the action of a punch and die were well-known, and as certainly there could be no difficulty in putting a heading devise on each side of the machine and head the two blanks, at the same time, there appeared to be no question but that with capital and a fair exercise of mechanical skill, a machine could be made to work successfully. It fell to my lot to undertake the building of such a machine, and so well did I plan and arrange the mechanical movements, and proportion the parts that the machine cut, transferred, gripped and headed the very first two nails perfectly, and yet there had been one element in the calculation omitted, and the machine never cut, nor never could be made to cut one hundred nails in succession without "balling up." The scale upon the iron crumbling off at every cut so filled in among the mechanism as to clog it completely. This illustrates the difficulty of taking all the points into consideration, for I believe the scale on the iron was something that not one mechanic in ten thousand would have thought of,—from it you can learn one lesson. Remember in your practice that plausible as a scheme may appear—sure as you may be that the mechanism is correct, there may be a little scale on the iron which has escaped your attention. It is a repetition of these lessons that makes old men less sanguine than young men, in regard to the success of their plans. In justice to myself, and to satisfy a curiosity I fancy has been excited in you to know more about the nail machine failure; I will add that the first failure had but very little effect in discouraging me, even then, when I had had much less experience than since, I planned and changed the machine, not only so as to make it less likely to clog, but arranged it so as to drive different parts by friction, that they might slip rather than break and also put on an automatic stop motion, so that when anything happened the machine would stop still. Though these devices proved mechanical successes, the machine remains a failure; for the stop-motion proved to be the busiest part of it.

Yet I believed in the possibility of making the machine work, invented new devices, designed new framing, added to the convenience of the machine without adding to the complication, started out with new hopes and built two machines from the new plans beside a third and simple one for cutting brads. These machines, excepting the brad machine, were as great failures as the first, unless one could get a little encouragement from the fact that perhaps they were good for five hundred nails instead of one. These discouraging trials occurred in a midland village of England when I was away from,—not friend. No, I have always been fortunate in making friends wherever I was—but away from Americans and mechanical counselors. It is a good thing to have some one to talk with when getting up a new invention. At the same time a similar machine was being built in this country by a friend, but it was scarcely more successful. However, neither of us lost faith in the possibility of making a machine that would go, but more money was needed and acquired, and my friend continued with the cooperation of one of the leading mechanical engineers of New York city in the trial of other machines.

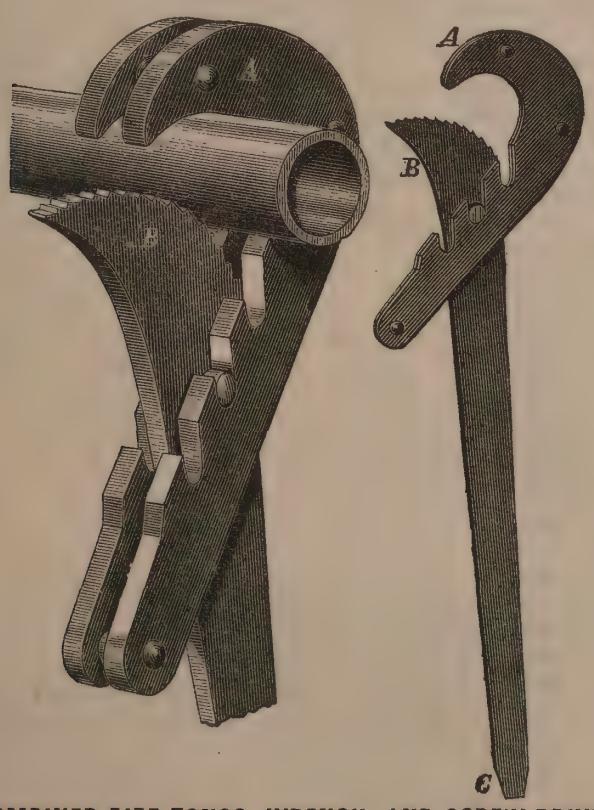
Three or four years later I conceived the idea of working the machine in a different form from any that had been tried, and so thoroughly did I study the matter and simplify the mechanism, and so fortify myself against what appeared to me to be every contingency, that my faith that the machine would work was as firm from pure reason as it had been from hope in the first case. I believed it could not fail to go, but it did, and then, after the building of seven different machines, after the loss of seven years of time and after the expenditure of twice that number of thousand dollars in money, nails are made one at a time still. If all the sleepless nights, all of the worrying thought, all the ingenious devices, schemes, and plans drawn, all the castles in the air built from imaginary fortunes, could be piled upon the real work done, it would build me a monument, I think, of little less than three million feet high. And were things judged by their own merit, rather than the success of the scheme in which they are connected, I am selfish enough to believe there was sufficient ingenuity embodied in that nail machine to make three or four feet of that monument merited. My faith in the infinity of mechanical possibilities is so strong that I still believe the machine can be made to work.

But let us stop here and turn back to our consideration of successes and failures, and take an example of another kind. It is not necessary to go over again with you the argument showing that long bearings, when properly constructed, are better than short ones; I only mention it because it has furnished the most numerous illustrations in which practice is wrong and theory right. A practical man after accepting a statement that a long bearing is better than a short one, because it is made by one in whom he has faith, has a long box pattern made for his line shaft bearings. He sets his best man to fitting a set of them up, his shaft is turned as true as a piece of round iron can be turned in the old lathe, and the boxes are bored or reamed as true as can be done with a flat reamer.

The boxes are set as true on the timbers as his best carpenters can set them by a chalk line, and bolted firm, very firm, perhaps four bolts instead of two; the line shaft is connected and set running, it begins to warm up at once, the machinery cannot be stopped, oil is poured on by the can-full, still the heat goes up, the oil begins to burn, medicated lubricants are applied, iron dust begins to roll out of the boxes, and to save farther destruction, the works are stopped. When the shaft is examined, it is found to be grooved in places and bits of iron welded on in others, the box which had looked so nice one half-hour before is grooved up like a wash-board and the proprietor makes the decisive remark, "That's the last time you'll catch me with long bearings—or in any of your other scientific notions. Now you will remember the theory of long bearings requires that certain conditions be complied with. First that the bearings be round and straight, that the box be round and straight and just enough longer than the bearing to admit of a film of oil between the two, and the oil kept there, that the boxes be in absolute alignment, and the shaft straight, or that the box be self-adjusting, so as to line themselves or to conform to the shaft, if it is not straight. Now, it is evident that not the first one of these conditions could have been complied with, in the case of the line shaft mentioned, still, it is found that though the shaft and box are not absolutely true with self-adjusting boxes, line shafts run perfectly satisfactory. However long a box may be, if it is out of line, the bearing is very short, simply binding across the corner, breaking through the film of oil, running iron upon iron, and destruction follows.

When a machine or structure fails to fulfil the expectations, a scientific examination will almost invariably determine the cause. To be sure, there are far too many boiler explosions in which the jury are compelled, by the conflicting testimony, to return a verdict of "accidental death," but it is because the jury accept opinions as evidence rather than facts and principles.

(To be continued.)



COMBINED PIPE TONGS, WRENCH, AND SCREW-DRIVER.

The accompanying illustration represents a device recently invented by Messrs. States & Cook, of Topeka, Kansas. It is a combination of the three tools that the gas and steam fitter has the most constant need of—the pipe tongs, the wrench, and the screw-driver.

The double jaw or clamp, A, laterally connected by stay pins, is curved, and has its lower part notched in order to form a support for the pivot pin of the single jaw, B, which enters between the double clamp, A, referred to. The jaw, B, has an eccentrically shaped and serrated clamping end, and has the lower end or handle so shaped as to answer as a screw-driver. The action of the jaws is apparent from the figure.

S. A.

BRICKS AND BRICK MAKING—XXIII.

LOCATION. In determining the location of a yard, (a most important consideration), there should be selected one with a sandy bottom (not of a nature that will settle), dry and solid, near to a good clay bed and to railroad or water frontage, or both, according to the mode and direction of shipment proposed. The bottom must be solid and firm, in order that it may not sink with the weight of the kiln. If it is proposed to ship by water, it is advisable that the whole length of the yard have a proper frontage on water deep enough for vessels to load close to the shed; and that the ground lies high enough to be secure against freshets, while at the same time no higher ground could slide down upon it. Should it be proposed to ship by rail, it is desirable to be near a main line, to diminish cost of siding. Where the brick are to be removed by carts, the yard should be near the main highway and should have a good, hard, level or well-graded road therefrom.

Where "dry clay machines" and drying chambers are used, there will be needed rather less room than where drying is done on floors, and "slush machines" are used. If we estimate for a yard to make 40,000 brick per day, (capacity of 40,000,000 per year of 100 working days, where open-air drying is resorted to,) we would need two working moulding machines and one reserve, each making 20,000 per day, and must have for each machine at least two drying floors, each sufficient to receive 20,000 bricks. It is better to have drying floors enough for three days' run of each machine. But to allow room for only two days' run for each machine, we must have a floor 300×200 feet. On this we could lay 16 rows, each of 220 moulds or 1320 bricks, with an 8-ft. space across the yard in front of each machine, and a 4-ft. space at each side, and the same between the machines to hack the brick up. Between the hacks or in the 8-ft. spaces there is room to pile battens and saddles when these are not in use.

We should place the moulding machines at one end of this floor; and back of them should be an embankment about seven feet high, and in length the whole 300 feet width of the floor. This bank should be retained along the drying floor by a wall or by timbers; it should be level on top, back towards the clay bed. At the other end of the floor from this bank, and level with the floor, should be the kiln-shed space, 300 by 80 feet wide, thus allowing a width of 32 for the kiln and 22 feet on each side for wood, &c. Where the yard is on a water front, and shipment is made by vessel, there should be a further clear space outside of the kiln-shed, and say 20 or 30 feet wide, to permit of loading vessels without crowding on the kiln ground.

Where there is a kiln-shed it should be over the whole of the kiln ground, and should be strong and compact, although not too expensive. The following specifications therefor are given by the Messrs. Allen:

"It is usually done by first setting firmly in the ground a row of posts parallel with the edge of the floor; these posts must be straight, strong timber, about eight inches diameter at the small end, and set sixteen feet apart from centre to centre, and of sufficient length that the plate that is framed along on the top of them will be eighteen feet above the floor of the kiln.

Another such a row of posts will be set parallel with and directly opposite to them, leaving a clear space of thirty-two feet between the two rows on which the kiln will stand. These posts will, as before stated, have a plate framed on the top of them, which plate should be square timber at least eight inches square, and the posts must be tied together on top by having a rod of three-quarter round iron passing from one row of posts to the other row, one rod at each post, as near the top as possible, and drawn tight with a nut at each end, or, what is better, with a strong key outside and a turn-buckle in the centre.

In either case let there be a wide, strong plate of iron between the wood and nut or key, erect from the plate-rafters, six feet apart, of sufficient pitch that a board sixteen feet long on each side will cover the space. The rafters will be fifteen feet long. Bind these rafters together by firmly nailing one and one-quarter inch plank the whole length, two rows of plank to each set of rafters. Form of one-inch boards a cap at the peak the whole length of the rafters, similar to a gutter turned upside down.

One row of the one and one-quarter inch plank that is nailed to the rafters will be about one foot from the edge of this cap. Now, by having boards one inch thick and passing one end under the cap, and dropping it down flat, the weight of it will keep it in its place, and the cap on top will prevent rain from entering at the top.

These boards can be held in their place at the bottom by a strip of board nailed along the plate in such a manner that the ends of the boards can be passed under it by shifting them a little to one side. These boards will require to be straight-edged and laid close together, and they will not only shed all rain or snow, but they will remain in place without a single nail being driven into them, and can at any part of the shed be taken off or put on in a few moments. This will be found a great saving of lumber, as the boards have always to be taken off from directly over the kiln as the fire gets to the top. Many boards would be broken if nailed, and a great deal of time lost.

Outside of each of these rows of posts and parallel to them set another row same distance apart, but of lighter timber, and outside of these another row, of still lighter timber. The plates of both these rows will be of sufficient height so that twelve-foot boards will reach the distance, forming a pitch to the roof somewhat less than the first row of sixteen-foot boards.

The plate on the outside row of posts should be nine feet high in the clear.

The boards on both these lower rows should be well nailed and the joints battened.

Form a gutter under the eaves of the shed each side.

Close up both ends of the shed, and your kiln will be safe from the weather. When finished, your shed will be 300 feet long and eighty feet wide over all.

The ground on which the kilns are to be set must be firm, solid, and graded up to a height to be out of danger from being overflowed or wet by rise of tide or freshets or heavy rains.

It must be made perfectly level and paved over with brick or stone, to have a hard, level bottom. The paving, however, is required only on that part of the shed where the kilns are to stand.

The drying-floor should be graded to about the same level as the kiln-shed.

It should be filled in with one or two feet of coarse, dry sand, then twelve to fifteen inches of clay cut fine and well packed down, and the whole faced with three or four inches of fine clay and loam, well rolled down with a heavy roller, or packed hard by being stamped with wood-stampers, and scraped off to a smooth, hard surface free of cracks or uneven places.

When finished it should be level, or nearly so, on a line running through the centre of the floor parallel with the kiln-shed, but must be about eight inches lower at the two outside ends. This will at all times keep it dry, and during heavy showers cause the water to run off both ways from the centre to each end parallel with the hacks. Surround the drying-floor on all sides with a ditch of sufficient capacity to at all times carry off all the water from the yard.

A yard thus built will, with very little care, be at all times dry, smooth, and in good order for work. G.

[To be continued.]

CASTING BABBITT BEARINGS.—The Keystone Portable Forge Co., of this city, kindly gives us some points relative to its successful practice with Babbitt metal bearings. The first usage was to run the bearing on a highly finished steel mandrel of the exact size of the shaft, and then to ream the bearing out a trifle to make a running fit. The present and improved practice is to run the box on a mandrel a size larger than the shaft, and *not* to ream. By this means the skin of the Babbitt casting is not disturbed, and the bearing runs cooler and longer.

[Copyrighted.]

SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

IV.

THE ANGLE OF ADVANCE.

On horizontal engines the centre-line *OI* of the eccentric forms, as already mentioned, an obtuse angle with the centre line *OK* (Fig. 2) of the crank. This relation will be modified when both the connecting rod and the eccentric rod are not operated in parallel directions, as may be the case with beam engines, or where a rocker or some other lever connection is interposed, for instance as shown in Fig. 10. But no matter

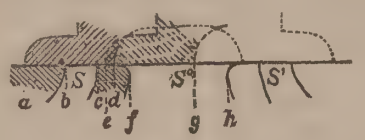


Fig. 10.

whatever the general arrangement of the engine may be, the centre line of the eccentric forms most always approximately right angles with the eccentric rod when the crank is in line with the connecting rod, or "on its centre." It should, however, never be precisely at right angles, but always more or less in advance of this position, in the direction of the rotation of the crank shaft, for else the valve would be in its neutral position at the beginning of the stroke; and since the port on the steam side is required to be opened, the eccentric must be advanced to make the lap and lead. The angle measuring this advance, namely, the angle formed between the eccentric line *OI* (Fig. 10) and the line *OY* drawn at right angles to the mean direction of the eccentric-rod, is called the "angular advance" or "angle of advance." The mean or neutral direction of the eccentric rod may be determined, in the drawing, by transferring the end *I* of the same into the centre *O* of the crank-shaft, and is shown, in Fig. 10, by the dotted line *OP*°. Whenever the end *P* of the eccentric-rod is guided in an arc, as in Fig. 10, this construction does not give a perfectly accurate result, but it will be sufficiently accurate for practical purposes, as the valve performs its principal operations when near its central position.

The "angular advance" plays an important part in the action of the slide valve and shall be denoted by the letter δ, as has already been done in the former diagrams.

In order to investigate the operation of its valve motion, any type of engines may be compared with a horizontal engine having the same slide valve, with equal travel, and equal angular advance. The valve diagram can therefore be drawn by first sweeping a circle for the path of the eccentric and then carrying in it the angle of advance from the horizontal centre-line in a direction opposite that of the rotation of the crank. From the points thus obtained in the circumference of the circle the lap circles have to be swept to complete the diagram.

It need hardly be mentioned that in cases where the motion of the eccentric-rod is transmitted to the valve by rockers or levers of unequal leverage the radius of the "path of the eccentric" of the diagram should not be made equal to the throw of the eccentric, but equal to one-half the travel of the valve.

In designing engines other than such where the connecting-rod and eccentric-rod are operated in a parallel direction, beginners often find difficulty in drawing the eccentric in its proper position to the crank, the angle of advance being given. The course to be pursued in such cases is as follows. Draw the crank *OK* (see Fig, 10) on one of its dead centres, and then draw the line *OY*, at right angles to the mean direction, *OP'*, of the eccentric-rod and carry the angle of advance, δ, from the last mentioned line, in the direction of the rotation of the crank-shaft. The resulting line determines the angle of the eccentric, but it must be decided yet whether *I* or *I'* (see Fig. 10) is the correct position. This can be done by assuming the movement of the crank to proceed, and considering which of the two points *I* or *I'* would cause the valve to open that port that will admit the steam on the proper side of the piston.

WIDTH OF PORTS.

The sectional area of the steam-ports should be made so large as to impede the ingress and egress of the steam as little as possible, and yet, on the other hand, so small as not to unduly increase the amount of clearance. By a series of carefully conducted experiments, it was found that the greatest velocity of the steam in the passages should be from 8,000 to 9,000 feet per minute, in small engines and such of a low pressure and low mean piston speed, and from 9,000 to 10,000 feet in large ones and such of high piston speed.

To compute, from these data, the area of the ports in any one special case, the maximum velocity of the piston must be found, which is equal to that of the crank pin, and hence equal to the product of the number of revolutions per minute into the periphery of the crank-pin circle. The conventional measure for the speed of engines, however, is the mean velocity of the piston, which is equal to the number of revolutions into twice the diameter of the crank-pin circle. The proportion of the mean speed to the maximum speed is therefore as two diameters to the circumference of a circle, or approximately as 7 is to 11; and hence the maximum speed of a piston is equal to its mean speed multiplied by the fraction $\frac{11}{7}$. The ratio of this speed to the allowed maximum speed of the steam in the passages furnishes the ratio of the area of the steam-ports to the area of the piston.

After the area of the ports is thus determined and a suitable length of the ports is selected, their width is found by dividing the area by the length.

It is well to make the length of the ports as large as practicable to procure a small width; for the travel of the valve is directly dependent on this width, and reducing the travel implies a reduction of the amount of work to be expended in overcoming the friction of the valve.

Some attention is to be paid to the dimension of the exhaust port. If it is made wider than necessary the valve must be made longer than otherwise, and a needless increase of pressure and a consequent loss of work from friction will result. If, on the other hand, it is made too narrow, the valve will, at the end of its stroke, cover it more than desirable and choke the exhaust.

In order to find the proper width of the exhaust port we draw the steam-port *S*, (Fig. 11) and over it one leg of the valve with the proper inside and outside lap, first in its neutral and then in its extremest position, removed towards the exhaust port. The distance *ab* is the outside lap, *bc* the width of the port, *cd* the inside lap, and *ae* or *dg* is equal to half the travel of the valve. The width of the bridge, *cf*, should be as narrow as possible, *i. e.* just wide enough to insure a perfect casting and sufficient strength to withstand the steam pressure. But if then the distance *ef* should happen to be less than a quarter inch, the bridge must be made wider accordingly, to prevent the possibility of a leakage of steam from the steam chest to the exhaust passage. If the bridge, on the other hand, is wider than necessary, to prevent leakage the inside corner may be rounded, as indicated in Fig. 11, to facilitate the passage of the exhaust steam. The other edge, *h*, of the exhaust port should have a distance from the inside edge of the valve, *g*, equal to the

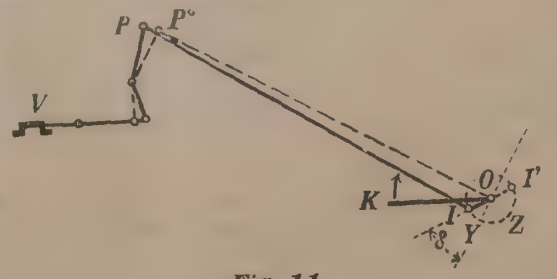


Fig. 11.

width of the steam port *bc*, or not much less in order that the exhaust steam need not contract beyond the area of the steam passage when entering the exhaust port. After the exhaust passage is thus located, the second port can be drawn on the other side and the dimensions of the slide valve can be determined by drawing the other leg of the same over the second port—as shown by dotted lines in Fig. 11.

VELOCITY OF THE VALVE.

A few words on the velocity of the valve in the different stages of its travel and on the rapidity of the opening and closure of the ports will not be out of place.

The valve moves with increasing velocity from the beginning of its stroke until it reaches its neutral position, where its speed is at the highest rate. Thereafter the speed again diminishes until at the end of its stroke the valve comes, for an instant, to a stop, and then reverses its motion. If we assume a perfectly uniform rotation of the crank-shaft, the velocity of the valve will always be in direct proportion to the leverage under which the eccentric is acting upon the valve; and as the selection of a scale for a graphical representation of this velocity is quite optional, we may choose the length of this leverage directly for the representation of this velocity. The maximum velocity will then be expressed by the length, *OI*, (Fig. 3) and this occurs when the eccentric is at right angles, or, in other words, when it passes the line, *OY*. When, however, the eccentric is, for instance, at *I'* the actual leverage is equal to *Oy'*, and the corresponding velocity is expressed by this length. In the foregoing it has been demonstrated that the triangles, *OQk'* and *OI'y'* (Fig. 3) are equal; and hence *Ok* = *Oy'*. From this it follows that the diagram can also serve to answer the question of the comparative velocity of the valve for any stage of the stroke. All that is needed for this purpose is a line drawn from the point, *Q*, of the diagram, at right angles to the respective crank-line, *OK'*, when the distance of the foot, *k*, of this line, from the centre, *O*, is the equivalent of the velocity of the valve while the crank passes the the line, *OK'*. To find the velocity of the valve at the point of the cutting off, when the crank is at *OE*, (Fig. 12) we draw the line, *Qk* at right angles to *OE*. The distance, *Ok*, then represents the sought velocity, and since the point, *k*, is the point of contact of the line, *OE*, and the lap circle, *L*, we may remember, as a rule, that *the distance of this point of contact from the centre, O, always represents the velocity of the valve at the moment of the cutting-off.*

The rapidity of the closure of the port depends not on

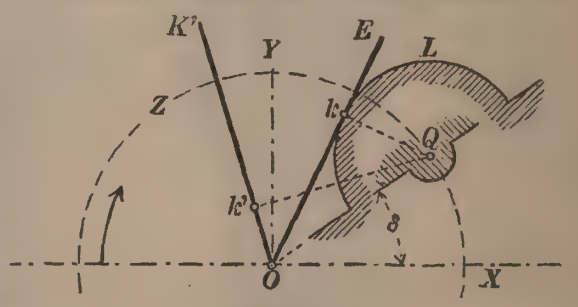


Fig. 12.

this velocity alone, but also on the velocity of the valve from the time it begins until it completes covering the port. Fig. 12 shows that, previous to the cutting off, when the crank is, say, at *K'*, the velocity of the valve, *Ok'* is smaller than *Ok*. This result is consistent with the preceding consideration, according to which the motion of the valve is increasing before reaching the centre of its travel, and as the valve cuts the steam off before that point by virtue of the lap, the velocity is evidently less before the time of the cutting off than it is at that moment. It will also be seen now that the sharpness of the cutting off suffers as the lap is enlarged, and for this, as well as for other reasons, the throw of the valve should be increased as more lap is added.

The length of the steam ports favors the sharpness of the cutting off, and therefore, if like results are desired, the velocity in other words, the throw can be lessened in the same ratio as the length is increased. It should, however, at the same time be remembered, that an increase of the length of the ports implies a proportionate decrease of their width, if the same area is to be preserved.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

[☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*]

ENGINEERING—CIVIL, MECHANICAL &c.

The Mississippi Jetties.—The latest news from the South Pass Jetties indicates that this great enterprise is rapidly approaching a condition that will thoroughly demonstrate its success. From day to day the deep channel is being ploughed through the narrow ridge still left at the entrance to the Gulf. As the work goes on now, a few days will show a channel of from twenty-two to thirty feet deep and three hundred feet wide quite through to the Gulf. During the last month, nearly a dozen vessels, with from fifteen to twenty feet draft, have been detained for days, and some of them for weeks, in the Southwest Pass, when they would have found a safe and easy channel through the jetties. Presently, however, prejudice and self-interest will succumb to the power of demonstration, and the jetties will become a great channel of the world's commerce. The following letter from Captain Andrews, the builder of the jetty works, will be of interest to our readers:

PORT EADS, July 11, 1877.

"The steamship Teutonia, for reasons best known to her captain and pilot, was brought up this morning from Southwest Pass and was put to sea through the jetties without any detention—not even once touching bottom. Her draft was twenty feet. The steamship Warrior also went down Southwest Pass, but her captain and pilot, for reasons best known to themselves, thought it advisable to turn around and steam to the head of the passes and go to sea through the jetties—which she did without a moment's delay.

"These simple facts should be sufficient to convince all unprejudiced minds that there is a good, safe, practicable channel through the jetties, notwithstanding the false rumors so industriously circulated through the city by parties who, I suppose, have some sinister motive for industriously circulating damaging rumors against the safety and practicability of the jetty channel.

"If the captains and agents of heavy draft vessels would make a personal inspection of the jettied channel, instead of listening to all the idle rumors that are to be heard on the streets, it might be to their advantage, and to the great saving of time in getting their vessels to sea. All such parties will at all times have every facility given them in making a personal examination of the jetty channel. JAS. ANDREWS."
—*St. Louis Trade Journal.*

A Pneumatic Railway in London.—A company is now being formed, we learn from the *Engineer*, to construct a pneumatic railway between the South Kensington Station of the District Railway and the Albert Hall. The line will rise the whole way to the Albert Hall, the ruling gradient being 1 in 48. The train will be blown through the tube by an ejector, in other words, a great centrifugal pump, two feet in diameter, fixed close to the District station, and worked by a pair of condensing engines exerting about 170 indicated horse power. The tunnel will be of brick, and the floor will be paved. Its cross-sectional area will be 105·5 square feet; at the end of the train is fixed a screen or piston, with an area of 104 square feet, the difference being allowed for windage. The train will consist of six carriages, of very light build, the rail gauge being four feet. This train will hold 200 passengers, and the total load will be thirty-two tons, or ten tons less than the weight of a single engine on the Metropolitan Railway. The maximum resistance at twenty miles an hour will be about 2,420 lbs., requiring to overcome it a pneumatic pressure of 2·6 ounces per square inch, and 162-horse power, assuming the useful effect to be sixty per cent.—*Nature*, xvi, 217.

The Reports of Progress at South Pass are meagre enough nowadays, but according to some of the New Orleans papers, failure is written upon the great work of Captain Eads, the evidence used being the preference of sea captains for the Southwest Pass. We published some weeks ago the sixth report upon the work, by Major Comstock, U. S. Engineer, and will endeavor to keep our readers posted on all authentic information which reaches us. Whether the experiment succeeds or fails, we hope to see Captain Eads and the engineers under him re-imbursed for what they have done or may do in solving the question for securing a permanent deep channel from New Orleans to the Ocean. Our views concerning the jetties have been pretty fully expressed heretofore and our columns are open for the advocates and opponents of the improvement, but we do not think it necessary to reproduce all the items which the partisan papers of New Orleans are careful to publish for or against, upon the reports of every skipper who takes a sounding. —*Eng. News.* iv, 171.

Inland Sea in Algeria.—MM. Dumas and Daubrèe have urged several objections to the proposed artificial inland sea in Algeria, and agree with M. Naudin, who read a paper on the subject at a recent meeting of the Academy of Sciences, that its sanitary effects would be deplorable. It is thought that to fill the shallow basins of the region which it is proposed to convert into a sea with salt water would be equivalent to reproducing in Algeria all the worst features of marshy plains. Captain Roudaire, who proposed the scheme, admits that even in the centre there would nowhere be more than about 80 ft. of water, and the whole coast line would have so little water that it would be little better than a sandbank with an admixture of salt and fresh water, upon which the strong tropical heat would act in the most deleterious manner for two-thirds of the year, causing a rapid decomposition of organic matter, and spreading contagion for miles in every direction. M. Naudin considers that there is no similarity between this district and Egypt, the climate of which country has been much improved by the creation of the Suez Canal and the plantation of trees; for, according to him, while Egypt lies between two seas, and is traversed by an immense river which has periodical overflows, the Algerian district is far from the sea, and is bounded by arid deserts.—*The Engineer*, xliv, 2.

Progress of the St. Gothard Tunnel.—The advancement made on the St. Gothard Tunnel during the week before last was 32.1 m. at the Goeschenen and 20 m. at the Airolo end. A progress of 7.5 metres per day.—*Moniteur Ind. Belge*, iv, 303.

German Patent Office Rules.—We have received a copy of the following preliminary rules which are to be observed until complete rules are issued by the Patent-office, under the new German law. Specifications and drawings must be lodged in two copies. The paper for the application and specification must be 33 centimetres by 21 centimetres in size. Of the drawings one copy must be made on white, thick, and smooth drawing paper 33 centimetres long and 21 centimetres wide, or 33 centimetres long and 42 centimetres wide, or 33 centimetres long and 63 centimetres wide; the drawing and all the writing must be executed in Indian ink in absolutely black lines, without colors or shading by the brush. The drawing must be surrounded by a simple marginal line at the distance of 2 centimetres from the edge of the paper. This line has also to enclose all the writing. The signature of the applicant is to be placed in the lower right-hand corner. At the top of the sheet a space of at least 3 centimetres in width is to be left within the marginal line for the number, date, and title of the patent. The second copy of the drawing may be a tracing of the main copy on tracing cloth. In the same the use of colors is allowed and even desired. The drawings must not be folded nor rolled. Measures and weights, if indicated, must be given according to the metric system. We believe a scale in such measurements is expected to be added. Powers of attorney may, until further decision, be lodged without attested signatures, but they must give the representative full authority to do all that is needful to prosecute the application.—*The Engineer*, xliv, 11.

MINING, METALLURGY AND MINERALOGY.

Arizona Anthracite.—Later and fuller reports concerning the coal mines in the Placer Mountains, a few miles southeast from Santa Fe—the objective point of an advancing railway from the east—seem to prove beyond any doubt that real anthracite has been found there. Professor Raymond, who is an authority on the subject, has examined one bed which has been developed a mile in length by one hundred and twenty feet in depth, and through a shaft some ten feet deep, from which several hundred tons have been mined; and another bed tunnelled for ninety feet. He finds that the coal of both these mines has the hardness, the specific gravity, the fixed carbon and volatile matter required by anthracite; that it ignites with difficulty but burns with intense heat. There is some slate, some iron ore and sandstone mingled with the coal in one of the mines, but there is nothing to repress the most sanguine hopes of the prospectors or cast doubt upon the belief that an inexhaustible supply of the best coal has been found near a rich silver producing country, and where fuel is a prime need for further activity. With this discovery Arizona should advance rapidly, and it is reasonable to infer that many important industries will be marked in the future of this region and adjacent States, and all northern Mexico.—*North American.*

Bruckner's Rotary Ovens for auriferous ores that are destined for the amalgamation process are becoming very popular in the United States, especially in Colorado. *Engineering* contains a detailed description of the oven and its achievements by Prof. Egleson. The washing is uniform, and the ore is constantly under the supervision of the attending workman, it requires but little fuel and manipulation, and the chlorination rises to 96 or 97 per cent.; the process is easily learned and requires but little machinery. An oven complete with one cylinder costs, in Colorado, from 2,500 to 3,000 dollars.—*Berg. u. Huetten. Ztg.*, xxxvi, 236.

Native Iron of Brazil.—The mass of iron found at Sainte Catherine, is, according to a letter from M. Guignet, doubtless of meteoric origin. The mass weighs 25,000 kilogr. and in consequence surpasses in size all others of similar origin heretofore found.—*La Nature*, v, 79.

Rich Mineral Discovery in New Hampshire.—The New York *Times* of the 10th inst. contains a dispatch dated Boston, July 9, stating that an enormous lode of copper, lead, gold, and silver, 20 feet in width and extending for miles, has recently been discovered in Milan, New Hampshire. The lode crosses the Grand Trunk Railroad 100 miles west of Portland.

The Gold Mines of Nova Scotia has been unnsually productive this year, and the Halifax Chronicle remarks that the returns, up to the middle of July, show a yield since 1st January, equal to the whole yield of last year, and rivalling the yield of 1867—the golden year of gold mining. From other districts the reports are similarly encouraging, the increase of yield being general, and prospecting stimulated by unusually rich finds.

—The anthracite coal of New Mexico contains 87.5 per cent. of fixed carbon and has much the appearance of the Pennsylvania article; the location where found is some twenty-three miles south east of Santa Fe.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

English Criticism on American Tanning Theories.—The views of our tanners on gallic acid and sour liquors, and on sweating and liming, as expressed at the Pennsylvania Tanners' Convention, are attracting some attention in England, as will be seen by the following, from the London *Tanners' and Curriers' Journal:*

At a recent meeting of the Pennsylvania Tanners' Association several matters were discussed which may perhaps be of interest to our readers as well as to our transatlantic cousins. They have a fashion, which we would commend to our own youthful Society, of providing a "knowledge box" at their meetings, into which any member may drop questions, which are afterward taken up and discussed by the Convention. One of these questions ran: "What is the value of gallic acid in tanning; if any, how long should it be used, and at what stage should it be dispensed with?" At the outset a gentleman remarked that the question would have been better understood if it had spoken of "sour liquor" instead of "gallic acid." We may add, that it would also have been more accurate, for the sourness of stale liquors consists to a very small extent of gallic acid, and in the case of oak, and probably of hemlock bark, no gallic acid is produced whatever. The sourness consists partly of acetic acid (vinegar) and of other acids of the same family, partly of complex acid products, the chemistry of which is but little understood. Leaving the chemistry of the question, however, the practical opinion was that for sole leather the sour liquor enabled greater weight and firmness to be obtained by plumping the leather, and that its action was most advantageous in the early stages of tanning. It came out in discussion that in hemlock tanning mineral acids were almost invariably used for plumping, although admittedly they damaged and darkened the buff. The explanation of this practice is, no doubt, that hemlock liquors yield little acid on fermentation, and as American tanners either sweat their hair off, or lime very lightly, some agent is indispensable that will plump the pelt. In tanning dressing leathers, on the other hand, it was recommended to avoid sour liquors, which by plumping the hide, made it too hard and brittle for finishing.

There was some discussion as to the use of heat in extracting bark, and the prevalent opinion seemed that the best results were obtained when the heat employed did not exceed 120° F. We believe that the practice is gaining ground in England, of spending bark with cold water alone, with a view to obtaining better color. No doubt in this respect cold water has real advantages, and theoretically, should extract

almost the whole of the tannin. In practice, however, this is difficult to accomplish, for, although the tannin may be perfectly soluble in cold water, it is contained in the bark in little cells of woody fiber and gummy and starchy matter, which are very slowly softened. On the laboratory scale it is possible to grind the bark so finely as to crush most of these cells, but commercially it is difficult to deal with it so finely powdered, as, in the leaches, it forms a compact and adhesive mass through which it is impossible to get the liquor to circulate. On the Continent bark is ground much finer than in England, but there the tanning is almost exclusively accomplished by dusting down in layers, and the leaches are only employed to complete the spending. If cold liquors only be used, the bark must necessarily remain a long time in the leaches for complete exhaustion, and probably 1 or 1½ per cent. (out of the 7 to 9 per cent. of new bark) will be left in at the finish. Our own impression is that, unless color be the one object aimed at, the best plan is to use the liquors warm, but not hot, say 100° to 120° F. If ordinary commercial tannin be placed in perfectly cold water it will dissolve but very gradually. If, however, the water be warmed even to 80° or 90° only, it will dissolve almost as rapidly as sugar does. We once tried an experiment in which three equal quantities of bark were covered with equal quantities of water —cold, tepid and boiling. After standing all night the strengths of the liquors were tested by Lowenthal's process, and were respectively as 12, 15 and 18. It is an important question whether, if heat be applied at all, it should be to the best leaches, or only to those nearly spent. Applied to the new bark it yields strong liquors, but the cooling of a large body of liquor is a slow and troublesome matter.

Another subject of discussion was "How much lime and how long a time is required to unhair thirty slaughter hides of an average weight of sixty pounds." One tanner limed five days in winter and four in summer, using about one bushel of lime, added half a bushel at a time, for a pack of thirty hides. Another used the same quantity (seventy pounds) for twelve hides, and limed in three or four days, warming his limes from 70° to 80°. He says: "I do not think it is a good thing to heat the lime, except to take off the cold. It is merely tepid water. We used to reel into water heated to 120°, and I am convinced too much warm water is not beneficial."

Adulteration of the Commercial Bromine.—Herr S. Reymann informs us, through the medium of the *Ber. d. D. Chem. Ges. zu Berlin*, that the commercial bromine contains about 10 per cent. of a foreign substance whose boiling point is between 80° and 165°, and which appears to be principally composed of bromoform. A too small percentage of bromine contained in a saturated bromine solution, can be detected and the characteristic smell of bromoform can be brought out very prominently by bringing pure bromine and a solution of iodide of potassa together and then bleaching the free iodine by means of hyposulphite of soda.—*Fresenius' Zeitschrift*, xvi, 344.

A New Registering Thermometer devised by M. Hervé Mangon, is thus described in *La Nature*. A long and fine capillary tube bent on itself and containing mercury, is supported in an iron frame; it passes through the stopper of a bell jar and terminates with a fine point in a mercury dish placed in one scale of a balance; the other scale contains a vessel of glycerine communicating by glass and india-rubber tubing with another glycerine vessel on the same level in an adjoining frame. When, on rise of temperature, mercury is forced out into the vessel, the balance is depressed on one side and an electric contact made, affecting an electro-magnet in the registering apparatus, which is composed of M. Redier's double wheel work with differential train (which we must not stay to describe). When the depression referred to has occurred a suspended float in the second glycerine vessel descends, and raises the glycerine in the first, increasing the weight in that scale. The curve obtained (from a pencil on moving paper) is of zigzag form, the wheel-work being in constant motion, now to the right, now to the left.

Relative Ages of the Sun and certain fixed Stars.—Professor Kirkwood closes a communication upon this subject to the American Philosophical Society with the following summary of his conclusions: 1. The history of the solar system is comprised within twenty or thirty millions of years. 2. From the fact that the larger component of Alpha Centauri radiates twice as much light as the sun, while the mass of the former is *less* than that of the latter, we infer the probability that our solar system is the more advanced in its physical history. 3. 61 Cygni seems to have reached a greater degree of condensation than the sun, since, on the hypothesis of equal destiny, the surface of the larger member is one-third that of the sun, while the intrinsic light is less than one-ninth. 4. The companion of Sirius appears to have reached a stage of greater maturity than the sun, while the contrary seems to be true in regard to the principal star.—*American Journal of Science and Arts.*

Industrial Uses of Bisulphide of Carbon. Up to the year 1850 the sole industrial application of bisulphide of carbon was in the vulcanization and dissolution of caoutchouc; but since later invention has found means of producing the material at low price, it has been applied to a multiplicity of uses in a large number of the arts. The extraction of oils from grains, the wholesale removal of fatty matter from wool, treatment of spices to obtain the same in soluble form, the fabrication of prussiate of potash by the Geles process, and of sulpho-cyanide of ammonium for the preparation of the toys called Pharaoh's serpents, the purification of crude paraffin, the manufacture of liquid fire for incendiary projectiles, and as a means of destruction of vermin, are a few of the principal employments of bisulphide of carbon. As respects magnitude, however, and future influence upon manufacturers, its adaptation to the utilization of waste residues is of chief importance, and is fast forming the groundwork of a new and distinct industry. The credit of first extracting the fatty matters from these products is due to M. Deiss, of Belgium, and by the aid of the bisulphide the former are obtained in quantities sufficient to serve for lubrication of machinery or the fabrication of soaps and candles. In order to show the rapidly increasing value of this useful substance, we have gathered quite a number of its most recent, as well as most important, applications, and are thus enabled to present a fair view of the various refuse matters in connection with which it is now employed. In the manufacture of fatty acids brown compact deposits are precipitated. These, mixed with sawdust, in order to facilitate the bisulphide, and treated with the latter, yield up to 20 per cent. of acids, which otherwise would go to waste. The pasty mass of metal filings, dirt, grease, &c., taken from car and wagon axles is first treated with hot sulphuric acid, then with bisulphide, and, lastly, washed and dried. This isolates the grease in a saponified state. Cotton waste, employed in or about machinery, is freed from its grease by sulphide, and is again available for use. Residues of the manufacture of beeswax, which formerly found no sale except as manure, selling at about eight shillings a hundredweight in France, are now subjected to the action of bisulphide, and an excellent yellow wax is extracted; the final residue is still useful as a fertilizer. Sawdust, which has served to filter oils purified by sulphuric acids, yields after pressure 15 per cent. of oil; again, 50 per cent. of oil is obtained from the muddy deposits due to the mingling of oils with sulphuric acid. These are washed in boiling water, dried, mixed with sawdust, and, lastly, treated with bisulphide. Balls of oleaginous grain, when they cannot be used as food for cattle, yield fatty matters; and their residue is an excellent fertilizer, as it contains large proportions of nitrogenized substances and phosphates. Bisulphide is also used to extract the grease from olives after they have been pressed, and from residues of tallow and suet after melting and pressure, also from the residues of the manufacture of cocoa. Bone fragments, when treated with bisulphide at 104 degrees of Fahrenheit, yield 12 per cent. of grease; they are subsequently unfit for the manufacture of gelatine, but answer excellently for the fabrication of bone black. The cleanings of wool cards, when acted upon by bisulphide, give about 30 per cent. of fatty substances, utilizable for the manufacture of soaps. It is evident from the great number of waste products, and the abundance of some of them, that a very considerable amount of greasy and oleaginous matter can be returned to the various industries through the new processes involving the use of bisulphide. The material has also been successfully employed in the scouring of wool, and in the extraction of bitumen from schists and bitumeniferous sandstones. In the latter case the quanity of bitumen obtained is from 4 to 5 per cent. superior to that furnished by distillation, which only gives in all from 7 to 8 per cent. MM. Van Haecht, Emile & Co., of Belgium, exhibited in the Vienna Exhibition a number of improved machines for carrying on these processes, and in which all species of fatty residues could be treated. The price of manufacture does not exceed, for certain purposes, twelve shillings per ton; about half a ton per hour can be treated. The loss of bisulphide is reduced to barely one-half per cent.—*Journal of Applied Science.*

Substitution of Chlorophyll for the Salts of Copper for the Preservation of Fruit and Green Vegetables.—At a recent meeting of the Academie des Sciences, M. A. Guillemau read a communication from which we glean the following:

"When vegetables are preserved by the appert process, they must first be bleached by being immersed for about five minutes in boiling water, and then plunged suddenly in cold water; the bleached vegetables are then placed in a glass or tin vessel and treated with water at 110° C. At this elevated temperature the chlorophyll contained is destroyed and the vegetable changes its color. This change of color can be partially remedied by the use of sulphate of copper in the bleaching water."

The purpose of the paper read was to establish the fact that the salts of copper can be advantageously replaced in all particulars by the exclusive employment of chlorophyll obtained from edible vegetables—a conclusion which is based upon the following observations:

"1. The chlorophyll of the vegetables disappears during ebullition.

2. The vegetable fibre and the starchy matter which is contained, when brought in contact with chlorophyll during ebullition almost completely saturate themselves.

3. The vegetables when but half saturated with chlorophyll during the operation of bleaching retain this beautiful coloring matter."

"These facts are of great importance and indicate the mode of procedure which is to be adopted. If some spinach, or, still better, the foliage of leguminous plants be treated with caustic soda, a liquor is obtained which gives with alum a lac of chlorophyll. This lac should be carefully washed to free it from sulphate of soda. This lac is easily dissolved by means of an alkaline phosphate or alkaline earth, and is composed of chlorophyll, alumina, and phosphate of soda. This dissolved lac is added to the bleaching water and on ebullition readily yields up its chlorophyll to the vegetables." Several flasks of peas prepared by this process were presented to the academy; of these, those that were completely saturated with chlorophyll possessed a shade of color impossible to be obtained by the use of copper, besides they were devoid of the astringent taste, as well as the poisonous effect, which characterizes those preserved by means of the salts of that metal. —*Annales du Génie Civil*, xvi, 371.

"Diorrexin," a New Explosive —The German engineers have for several years employed a peculiar explosive, termed "diorrexin" by the patentee, Herr G. Pancera, and is manufactured by the factory of Sistiana, in Triest, and that of Brunn, near Wiener-Neustadt. According to the analysis made by J. Fels, of Triest, the "diorrexin" possesses the following composition:

		In the dry explosive.
Picric acid	1.50	1.65
Charcoal	6.82	7.49
Beech sawdust	9.98	10.97
Potassic nitrate	38.93	42.78
Sodic nitrate	21.07	23.16
Sulphur	12.20	13.40
Water	9.00	——
Loss	0.50	0.55
	100.00	100.00

"Diorrexin" is becoming very popular in coal mining. Its explosive force is about equal to that of the Austrian blasting powder, its cost is one-fifth less, and is about 25 per cent. lighter.—*D. Ind. Ztg.*, 1877, 275.

The Value of Forests.—Mr. Landsborough, the well known Australian explorer, recently read a paper at Oxley, Queensland, in which he adduces a variety of interesting facts to prove that dense forests are on the increase in Australia, that the climate is becoming moister, and therefore improving, that the country is gradually ceasing to be favorable to sheep-rearing, and becoming agricultural, and seems to hint that in course of time the great central desert may yet "blossom as the rose." Formerly, when there were no sheep to keep down the grass, fires were frequent and terribly destructive to trees and all vegetation, but since the stocking of the country there is less grass for the fires to consume, and their ravages are consequently becoming limited in extent. Queensland, especially, Mr. Landsborough declared, is now so unfit for sheep pasturing, that no one thinks of making a living by them. The observations of this experienced traveller are well worthy of attention, and it will certainly be interresting to watch the changes caused by the presence of civilized men in Australia, as we know exactly its condition at their first advent.—*Nature*, xvi, 217.

Reduction of Mercury in California.—M. Patera. —The cinnabar is converted into calomel by the action of copper chloride; the calomel is dissolved in hyposulphite of soda, and sulphide of mercury is then precipitated by sulphide of sodium. The process is tedious and costly. Sieverking describes another process in the *Mining and Scientific Press* of San Francisco. He places the ground ore in casks with granulatedcopper, or, preferably, an alloy of copper and zinc, and agitates the mixture for twelve hours with a hot solution of cupric chloride. When a sample taken out shows the total decomposition of the cinnabar, a small quantity of zinc amalgam is added which effects the precipitation of all the copper which has remained in solution and causes the agglomeration of that portion of mercury which had been deposited in a pulverulent state. The agitation is continued for some time; the casks are then filled with water and allowed to settle. The amalgam, which is very compact, subsides; the liquid is carefully decanted and distilled; the residue from this distillation serves for the preparation of chloride of copper for succeeding operations.—*Bulletin de la Societé Chimique de Paris*, April 5, 1877.

MISCELLANEOUS.

American Institute Exhibition. — The forty-sixth Exhibition of this Institute will open September 12, in this city. Parties having novelties which they intend to bring to public notice should at once address the General Superintendent for blanks and information.

Imitation Pearls are now manufactured in Paris upon a large scale and with wonderful skill and ingenuity. The sand, upon which the whole art depends, is found in the forests of Fontainbleau. False pearls are lined with wax and scales of the roach and dace, which have to be stripped from the fish while living in order to retain the peculiar glis tening hue. The setting is always of real gold, and the fashion of the newest kind.

A Race between a Carrier Pigeon and a Mail Train took place on Friday last from Dover to London. The pigeon was of the Belgian breed, and was "homed" to a house in Cannon street. On the train leaving Dover it was thrown from a carriage, and was observed to circle round for a few moments, when it took its flight in a line between Sittingbourne and Maidstone, which would, of course, be the nearest route to London. Although the railway people were confident in the powers of their locomotive (the Continental express) the bird arrived twenty minutes before the train. The times are not given, but the pigeon must have flown at the rate of fifty miles an hour.—*Eng. Mech.*, xxv, 456.

Removal of Stains from Woven Fabrics.—*Mechanically Attached Particles* may be removed from all fabrics by beating, brushing, and allowing water to fall from an elevation upon the wrong side of the goods.

Mucilage, Mucus, Sugar Jelly. — Washing with lukewarm water will clear all goods.

Fats. — From white goods: Wash out with soap and lye. Colored cottons: Wash with lukewarm water and soap. Colored woolens: Lukewarm soap and water, or ammonia. Silks: Clean carefully with benozle, either, ammonia, chalk, clay, or yolk of eggs.

Oil Colors, Varnish, Rosin.—From all fabrics, except silks: Oil of turpentine, alcohol, benzole, and then soap. Silks: Benzole, ether, and soap very carefully, and in a very weak solution.

Stearine can be removed from all goods with strong, pure alcohol.

Vegetable Colors, Red Wine, Fruits, Red Ink. — From white goods: Sulphurous vapor or hot chlorine water. Colored cotton or woolen goods Wash in lukewarm water and soap, or ammonia. Silk may be treated in the same manner, but very cautiously.

Alizarine Inks. — From white goods: Tartaric acid; the older the spot the more concentrated. Colored cottons or woollen goods: If color permits, dilute tartaric acid. Silks: As before, but with great caution.

Blood and Albuminous Spots. — Simply washing out with lukewarm water, for all kinds of goods.

Rust, and Spots of Ink made of Nutgalls. — From white goods: Hot oxalic acid, dilute hydrochloric acid, and then tin filings. Colored cottons or woolens: Citric acid may be tried. White woollens: Dilute hydrochloric acid. Silks: Nothing can be done without increasing the evil.

Lime, Lye, and Alkalies in General. — From white goods: Simply wash in water. Colored Cottons, woolens, or silks: Much diluted citric acid, drop by drop upon the moistened spot, to be spread around by the finger.

Acids, Vinegar, Sour Wine, Fruit Juices, etc. — From white goods: Simply washing; in the case of fruit also with hot chlorine water. Colored goods, either cotton, wool, or silk: According to the delicacy of the material and the color, more or less diluted ammonia, to be spread around on the spot, moistened, drop by drop, with the tip of the finger.

Tar, Wheel Grease, as also Fat, Rosin, Carbonaceous Particles and Wood Vinegar. — From white goods: Soap with oil of turpentine, varied with the action of falling water. From colored cotton or woolens: Hog's lard to be rubbed on, and then soaped, and allowed to remain quietly; then washed alternately with water and oil of turpentine. From silks: As in the preceding, but more carefully, and instead of turpentine, benzole and a continual current of water falling from a height, and only upon the reversed side of the spot.

For cleaning silks soiled and greased, but not thoroughly discolored by acids, etc., the best agent is ox-gall diluted with lukewarm water and strained. Blood and albumen should simply be soaked in *cold* water.

Superficial Loss of Substance by Scorching. — For white goods: Rub over thoroughly with a paid dipped in hot chlorine water. Colored cotton or woolens: Whenever possible, color over, or raise up the nap. With silks nothing can be done.—*Boston Jour. of Chem.*

—The Portuguese African Exploring Expedition left Lisbon for Loanda on the 7th inst.

Honor Worthily Bestowed.—We are pleased to learn that at the late commencement of the Stevens' Institute of Technology, the honorary degree of Doctor of Philosophy—the first of the kind bestowed by the institute—was conferred for merit upon Prof. Henry Wurtz, on account of the great originality and value of his scientific researches and writings in the past few years.

Prof. Wurtz' numerous contributions to chemistry pure and applied, have been such as to entitle him to rank second to none in his profession, and the institution that has bestowed this well merited title honors itself as much as its recipient.

The Asbestos Packing Co., of Boston, Mass., reports that it is at present the only miner and importer in this country of foreign asbestos. Its officers are desirous of drawing attention to the growing importance of this mineral, with the view of aiding and hastening the possible discovery of asbestos deposits in this country equal in quality to the asbestos imported from certain favored localities abroad.

A Wonderful White Aquamarine has been found in Perthshire which, when cut, has produced one of the most brilliant gems ever seen. It is said by many competent judges to be equal to her Majesty's celebrated Koh-i-noor, its refraction being very great both by day and night. It is of a pure pellucid liquid white, and is known as the Scotch Koh-i-noor. Its hardness is 8·0, and specific gravity 2·76. Mr. Bryce M. Wright, F.R.G.S., is its possessor.

Supplies for the New Arctic Station.—The schooner Florence sailed from New London, Conn., on August 2d for the Arctic ocean. She goes to store at a station on Cumberland Island, the supplies upon which the Exploring Expedition, which is to sail next July under Capt. Howgate, U. S. A., will subsist; this will enable them to resume work after the long winter instead of coming home for food. The Florence is 56 tons burden, and is in charge of George E Tyson, of Polaris fame, of New London, as Master. The meteorologist and photographer is O. T. Sherman, of Providence, R. I.; naturalist, Ludwig Kumlin, of Madison, Wis., who goes under the auspices of the Smithsonian Institute. While the outfit is nearly wholly private, it promises ample returns and deserves a fair trial.

Bad Odors of Drinking Water.—We glean the fol lowing interesting item from the *Popular Science Monthly* for August. The city of Rochester draws its water from Hemlock Lake, thirty miles distant. Last year the water became offensive, giving rise to serious apprehension respecting its effect on the public health. From October to December there was emitted a fishlike odor; its source could not be traced. Similar annoyances have been observed elsewhere. Soon after the introduction of Croton water into New York, and of the Cochituate water into Boston, the fishlike odor prevailed for some time to a most disagreeable extent. While this odor is of most frequent occurrence, others of very different character are occasionally reported. Near Boston, last year the Bradlee basin became affected with an odor described as resembling cucumbers. About the same time the water of Springfield, Mass., exhaled the odor of green corn. In 1874 the water of Cherbourg, France, became intolerable from an odor indistinguishable from that of a pig sty. This same odor occurred last summer in Horn Pond, which supplies East Boston and Charlestown with water. The odor of decaying wood is not uncommon, especially in early summer.

A Spring Arrangement, by which the drivers of the fire-engines will not be liable to be thrown off while driving to fires at great speed, has been invented by a Philadelphia engineer—Thos. J. Hickey. It will not be patented.

— The largest single contract ever taken in this country from a foreign nation is the $17,000,000 one given to the Providence Tool Company by the Turkish Government. The Tool Company was three years in preparing to begin the work upon the contract, and now employ 2,500 men, who turn out 200,000 guns per year, or 600 finished guns in a day. These guns are the Martini Henry rifles. One of the side businesses of magnitude which has grown principally out of this contract is that of the Excelsior Box Company of Providence, of which James A. L. Amoreux of this city and South Hadley Falls is treasurer. The Excelsior Box Company is now busy making 20,000 boxes per year for the Tool Company in which to ship their guns to Turkey. Each box is made to hold twenty of the guns, and with such accuracy are the groove pieces for the interior of the boxes made that they do not allow a play of even one two-hundredth part of an inch of the arms, when packed with the muzzle tip and shoulder piece resting in the grooves. No other precaution is needed or used in packing the guns for shipment to Turkey. The machinery for the manufacture of these boxes was perfected in invention for the purpose. The company has still two years in which to complete the number of these boxes that they contracted to make; by which time, also, the Tool Company will have completed their immense contract with the Turkish Government.

—A survey of the Harrisburg and Potomac route has been made from Shippensburg to Chambersburg, Pa., and it is said that property holders along the line will donate the entire right of way. The road, if built, will run parallel to the Cumberland Valley road.

—Peru's example is catching all over South America, and the continent seems to be on the verge of a general revival of railway building. All the old plans are again up for discussion. One of the most interesting is that for a road from Buenos to the Pacific at Santa Rosa, Chili, which will tunnel the Andes at the height of 10,500 feet, the perforation being two miles long. It is now under debate in Congress of Buenos Ayres.—*Eng. New*, iv, 192.

—A direct cable communication is to be formed between Sweden and Russia, the stations being Grisslehamm and Aland.

—The German Astronomical Society, as it is generally called, but really the International Astronomical Society, meets this year at Stockholm, from August 30 to September 1.

— The Baldwin Locomotive Works have recently delivered some of their street-railway motors to the following roads: New Haven and West Haven R. R.; Newark and Irvington R. R.; Forest Home R. R. of Milwaukee; Hill and West Dubuque Street Railway of Dubuque, Iowa. These machines are all now doing regular service. On the Newark and Irvington R. R. a motor weighing 14,000 lbs. is hauling two fully-loaded cars over a grade of 5¼ feet per hundred, or 277 feet per mile. On the Forest Home Railway of Milwaukee, a motor weighing about 13,000 lbs. hauls two loaded cars over the road, two miles in length, with grades in the neighborhood of 200 feet to the mile, in ten minutes. It has made the round trip in twenty-three minutes; it has also hauled three cars over the road. The Hill and West Dubuque Street Railway has the heaviest grade which has yet been worked by a steam motor. The maximum grade for a short distance is 9.7 feet per hundred, and at other points it is 9.3 feet per hundred. A motor weighing about 17,000 lbs. takes one fully-loaded car up this grade, and could take two cars with ordinary load if required. On one occasion, when drawing one open car, 125 passengers were on the car and 12 on the motor, besides the engineer and conductor; and this load was taken up the steepest grade. The steam brake with which these machines are supplied was found to work effectively in descending the inclines.

As showing the interest which is manifested in the subject of steam traction for tramways abroad as well as in this country, the following extract from a letter from a correspondent of the Baldwin Locomotive Works, in Paris, is given:

. . . . . "I may inform you that steam traction for tramways is making a great advance both in England and France. At the present time, here in Paris, thirty-five machines are in daily use, and they are now about to open another line of six miles, coming right into the heart of the city, also to be worked by steam. In several provincial towns, also, tramways are being constructed, to be worked by steam power. I let you know what is going on here so far as I can, thinking it may prove interesting to you, as similar steps are being taken in your country. If at any time I can give you any further information, I shall be happy in doing so. Your prices, in comparison with English and foreign makers, come out very favorable, and if it were not for the high duty, they would come in very strong competition with them."

— The Ethnological Museum of Berlin, which the celebrated traveler Schweinfurth declared to be the richest of its kind in existence, has just purchased, for the sum of 75,000 francs, all the ethnological curiosities collected in Africa by the Italian Piaggia. The collection will occupy a special compartment of the Museum of Berlin, and will bear Piaggia's name.—*La Nature*, v, 111.

— All the princes of Hohenzollern are compelled to learn a handicraft—the right kind of compulsory education.

— The Massachusetts Society for Promoting Agriculture is offering prizes for the best and second-best yield of white-oak trees, white pine, Scotch pine, and European larch.

— The principle of government endowment of scientific research is recognized by England. Twenty thousand dollars will be paid out during the present year, on the recommendation of the Royal Society, to thirty-five persons, in sums from $250 to $1500.

— The most important Western cities—Cincinnati, St. Louis, Chicago, and Louisville—have been profited by the fairs and exhibitions held in them. St. Louis is preparing for another.

— The dentists deposit annually half a ton of pure gold in the American mouth.

— A good-sized elm, plane or lime tree, it is calculated, will produce 700,000 leaves, giving an area of 200,000 square feet. Leaves absorb deleterious gases as well as exhale oxygen.

— Stoves are being sent to Australia by the Detroit Stove Works.

— The Sandusky Wheel Company, Ohio, manufactures annually 20,000 sets of wheels for carriages and buggies.

— A number of Pittsburg firms of manufacturers have agreed to send an agent to sell their goods in South America.

— A vein of silver, bearing 65 per cent., containing gold enough to pay expenses, has been discovered in Mississippi.

— The United States Iron and Tin-Plate Company, Pittsburg, is making steel-plate shovels from the best Bessemer stock.

—The Northfield, Conn., Knife Company is doubling the size of its factory. ——Jones & Co., of West Troy, shipped ten horse-cars to Bombay August 1.

EDITORIAL CORRESPONDENCE.

Editors of POLYTECHNIC REVIEW: I am obliged to Mr. Bilgram and your correspondent C, for pointing out an error in my article on the antifriction curve.

P' does not represent the pressure per *unit* of surface of the curve, but per *unit* of its *horizontal projection*. The latter increases as the radius decreases, whereas the former is uniform, as your correspondents have clearly demonstrated.

J. HAUG.

ANSWERS TO CORRESPONDENTS.

F. L., Germantown Avenue, city. We would suggest to our correspondent to dampen a sponge or soft linen rag with weak glycerine, and apply it to the kid gloves. This would doubtless preserve their pliability, keep them from becoming stiff or wrinkled, and would allow of their being ironed to look like new. To remove ink stains from such gloves we would suggest diluted muriatic or oxalic acid, to be followed by the application of ammonia to the treated part.

F. L., Germantown Avenue, Philadelphia—asks a number of questions concerning the Great Corliss Engine at the Centennial, which we answer below as explicitly as possible: The engine was not sold at the close of the exhibition, as has been reported, but lies now dismantled, portions boxed and other portions unboxed, upon the floor of Machinery Hall, of which it was once so conspiciuous an adornment. The engine we are told was rated for 1,500 H. P., but it was never called upon to exert its full capacity; the demand upon it never having exceeded about 600 H. P. Of the 20 boilers, we are informed, half were used alternately to supply the engine with steam. The average pressure carried was about 80 lbs. As to the cost of building the engine, or the amount of remuneration received by Mr. Corliss, we cannot inform our correspondent.

MEASURING MACHINES. (J. A. F., Lynn, Mass.) So far from questioning the possibility or accuracy of ten-thousandths measurements by the Cornell machine, you should bear in mind that long ago Sir. Joseph Whitworth constructed a machine which measured and recorded to millionths.

FELTING BOILERS. (W. E. A. & Co., St. Louis.) If you wish to use your boilers for heating the room in which they are placed, we would not advise felting. If, on the contrary, you wish live, dry steam to drive your engines, or to use elsewhere than in the boiler-room, we would advise covering them thickly with a non-conductor, leaving an air-space next the shells.

OIL LUBRICATION. (C. P. B., Newark, N. J.) That this does not always prove an advantage in reducing friction may be seen by oiling two cylindric gauges which have a loose sliding fit; the oil will oppose their passage. But if they have a very tight fit, the same oil will aid the motion and facilitate the entrance of the internal gauges.

Wire Rope Transmission.—[C. J. R., Dayton, Ohio.] Wire ropes from 3-8 to 3-4 inches in diameter transmit from 3 to 250 horse-power.

Lift of Safety Valves.—[A. J., Lawrence, Mass.] This should not be more than 1-40 the diameter; some say 1-48.

Heating Feed Water.—[T. A., Conshohocken.] Heating from 68 deg. to 200 deg. F., you should save about 15 per cent.

The Dudgeon Rotary Engine.—[L. and D., Cleveland.] This admits the steam at the ends, and to one side of the line of centres, of a pair of spur wheels.

Shunting.—[H. A. B., Lynn, Mass.] We Americans call this "switching."

Type Distributing Machines.—[F. R., Wheeling, W. Va.] Distributing is much easier than composition, especially "justified" composition.

"Bevil" or "Bevel."—[C. J., Zanesville, O.] Either way is correct spelling; the latter the most generally used.

Gas Engines.—[Printer, Binghampton, N. Y.] One firm in England has made and sold over 4000 of one patent, and we should say that this was a tolerable guarantee of "practicability."

"Positive Pressure" Blowers.—[R. L. J., & Co., Newark, N. J.] We would say that any blower that ran as easily with the discharge outlet closed, as with it open, hardly gave a "positive pressure."

The Scott Legacy Premium and Medal.—[F. T., Ansonia, Conn.] This is given by the "Committee of Science and the Arts" of the Franklin Institute; the Medal is of bronze, and the premium is $20 currency. Write to the Actuary of the Institute, 15 S. Seventh St., Philadelphia.

Covering Steam Pipes.—[R. K., Akron, O.] Your 2-inch pipes would require to be felted 6 inches thick in order to properly deliver all of the heat in the steam, without loss from radiation. Felting an inch thick will reduce the loss from radiation down to 10 per cent. [of the units of heat in a given length.]

The Fireless Locomotive.—[C. R., Galt, Ontario.] This was originated by Dr. Lamm of New Orleans, and is a working success.

The Whitworth V Thread.—[B. L., Trenton.] This has an angle of 55 deg. at top and bottom; and top and bottom are rounded off one-sixth. This gives a depth of only ·64 the pitch, instead of ·96, which it would have if the angles were not rounded.

Friction Wheels.—[T. F., New Orleans.] Your friend is right, technically speaking. The wheels on which the axles of some grindstones roll are anti-friction rollers or wheels. Friction wheels drive or run together by mutual friction.

Burning Sawdust.—[A. R., Oshkosh.] Make the space between grate bars only 3-16 to 1-4 inch.

Temperature of Chimney Gases.—[H. and F., Baltimore.] Stick a steel wire into the chimney and note the "temper color;" ranging from faint yellow, indicating about 430 degrees F. up to brown, 490 deg. and red, 510 deg. The temperature ought not to be more than 100 deg. higher than that of the steam. For instance, steam at 75 lbs. pressure has a temperature of about 308 deg. F., and the chimney gases should not show more than 410 deg.

Horse Power.—[B. F. L., N. Springfield, Mo.] There are about nine different standards varying 300 per cent. and more; and we do not care to get involved in this discussion again. See back numbers of this journal.

Super-Heated Feed.—[C. T. F., Pittsburg.] You can certainly heat your feed above 212 deg. if your heater is in the stack, and between the pump and the boiler. Feed has been heated to 315 degrees; the heater is then in reality a supplemental boiler.

Coal and "Combustible."—[F. L., St. Louis.] The average coal will contain about 75 per cent. of pure carbon; it takes from 115 to 140 cubic feet of air to consume it.

Sections of Punches and Dies.—[N. F. K., Auburn, N. Y.] The die aperature should be cylindrical or parallel-sided at the top or entering portion; this enables it to be sharpened by simply grinding its flat upper surface, without altering the size of the hole. The lower portion should have an increasing taper to reduce friction and permit the burr to fall out by its own weight. The greater the difference between the diameters of the punch and the upper die-aperture, the more conical will be the hole punched. The punch end or face should be inclined about 3 deg. to 5 deg., so as to cut cleaner, and less rounding, and bring less strain on the machine.

Difference Gauges.—[G. H. F., Chicago.] These are usually made in threes, those for gauging rifle bores rising by 5000ths of an inch.

Small Drilling Machine.—[C. E. G., N. Y.] Your device is only a modification of the long known Archimedean drill stock, which is very wasteful of power and wears rapidly.

BIBLIOGRAPHICAL NOTICES.

FINAL ANNOUNCEMENT OF THE WOODRUFF SCIENTIFIC EXPEDITION AROUND THE WORLD. Indianapolis, 1877. Pamphlet, 40 pp. 8vo, with map showing route.

This interesting pamphlet gives the details of a proposed voyage around the world, to occupy two years, the object being to afford to students and others the opportunity "to visit points of general and special interest on a route around the world, to study the arts, archæology and present condition of the better-known countries, and the geology, geography, fauna and flora, as well as the history and character, of those less known, and to make collections in the various departments of science."

The idea of this expedition is certainly admirable, affording, as it will if the plan as laid down is literally carried out, an exceptionally fine opportunity for study and observation to its participants, with the peculiar advantages possessed by an organized expedition.

An effective corps of professors, constituting a scientific faculty, will accompany the expedition; and so far as we can glean from the prospectus before us, it promises to present educational facilities of the most interesting and valuable character. The route selected is one that appears to combine the greatest opportunities for original study with the greatest economy of time; and the scheme has the endorsement of such eminent professional names as Profs. Asa Gray, Newberry, Henry, Dana, Verrill and others. A fine steamer, provided with special facilities for meeting the objects of the expedition, has been provided, and will be commanded by officers of the United States Navy. The expedition will start on Saturday, October 1st, 1877, from New York, and will return to the same port about October 1st, 1879. Those desiring to inform themselves further concerning the expedition are invited to address Daniel Macauley, Indianapolis, Indiana.

THE WAGES QUESTION: A Treatise on Wages and the Wages Class. By Francis A. Walker, M. A., Ph. D., Professor of Political Economy and History in Sheffield Scientific School of Yale College; Superintendent of U. S. (ninth) Census; Chief Juror of Centennial Exhibition, and Author of Statistical Atlas of the United States. 428 pp. 8vo, cloth. Henry Holt & Co., New York.

We acknowledge the receipt of this important book (which has been placed aside through pressure of specific work) on a question that is probably the most unsettled of any that has grown out of the relations which the component parts of society bear to one an other. The events which have shocked our land bring this subject of wages into prominence. We must postpone other mention of this work until we can give it proper consideration.

SELECTED LIST OF U. S. PATENTS.

JULY 10, 1877.

Patents granted July 10, 1877, 258; Reissues, 3; Designs, 4; Trade Marks, 5; Labels, 8.

192 817. SAW MILL DOG. A Cunningham, Milwaukee, Wis.

The timber is securely held upon the head block during the operation of sawing by means of two sets of dogs, one having single straight teeth attached to a segmentally slotted plate, having studs upon its under side, which work in inclined slots in the standard; the other having doubled curve teeth pivoted to said standard and providid with studs, which work in the slots in said plate, both sets being operated by a pivoted lever connected to the slotted plate by a link.

192,823. MACHINERY FOR THE MANUFACTURE OF POTTERY. R. Gracey, East Liverpool, Ohio.

The forming tool is directed by a trammel and thereby has imparted to it an elliptical movement of any desired eccentricity. The potterv ware is therefore moulded in any desired oval form.

192 874. MACHINE FOR SPLITTING HOOP POLES. Jas. A. Peoples, Chicago, Ill.

Hoop pole blanks, either round or angular, are fed to splitting knives, mounted in a removable head by means of an upper flanged roll, and a lower roll having a V groove in its face, the tension of both upon the blanks being maintained, while admitting of the movement of each roll toward or from the other. The split blanks are discharged by two pairs of rolls, two of which have an independent movement in their bearings while maintaining an equal tension on the blanks.

192 881. METAL PULLEY BLOCKS. E. U. & W. L. Scoville, Manlius, N. Y.

The metallic case is formed with one or two conical axis pins upon which the metallic wheel revolves. There is also a central bolt whereby the sides of the case may be drawn together to compensate for wear upon the conical bearing.

192,886. STOPPING MECHANISM FOR SEWING MACHINES. Chas. H. Warner, Sturbridge, Mass.

A stop mechanism is operated by a lever, and is so constructed that when said lever is moved in one direction the needle will be stopped at the bottom of its stroke, and by moving said needle in the other direction it will be stopped at the top of its stroke. By continuing either motion of said lever the pressure foot will be raised from the work. The fly wheel will be unclutched if it is turned the wrong way.

192,897. LOOM TEMPLES. W. H. Burns, Worcester, Mass.

Bars are arranged on a roller so as to have an angle of inclination to the plane of the roller heads. This arrangement produces the effect of the spiral set and tends to draw the fabric outwardly. The teeth are arranged in pairs, and each pair is in one piece. The bars and teeth may be readily removed and in case of breakage new ones may be substituted.

193,917. BAND SAW MILL. J. R. Hoffman, Fort Wayne, Ind.

The log carriage is operated upon inclined ways from the upper saw pulley, for the purpose of straining the saw, the upper pulley shaft-supporting frame is horizontally adjustable, so of to tilt the saw, and strain either the front or back edge. The inclined ways are for facilitating the gigging buck.

192,939. IRONING APPARATUS. H. Monk, Troy, N. Y.

The machine is reversed by a double clutch which is reciprocated by a lever, having a forked end engaging with a pin upon the extremity of a bell crank. The clutch is held in position by two weighted drop fingers alternately engaging with a lip upon the actuating lever, said fingers being operated by the pin which throws the forked actuating lever back and forth. The bell crank is weighted, and is moved by the traveling ironing table, which carries a pin adapted to engage with said bell crank at the proper moment. The rack bar beneath the table is drawn into engagement with the actuating pinion by a stud upon the latter hooking into a bent finger upon the end of the rack.

193,951. COTTON CLEANERS. Charles O. Thomas and Thomas Robertson, Murfreesborough, Tenn.

A long cylindrical case inclosing a circle of stationary rods, and a central revolving shaft with projecting arms or beaters arranged spirally thereon. The cotton is passed to the action of the beaters through an opening in the circle of rods near one end, and is forced by the beaters through the opposite end of the case, where it is discharged. The seeds disengaged by the beaters fall through a grated casing into an air blast, by which they are expelled from the machine.

192 930. SHEDDING MECHANISMS FOR LOOMS. Wm. R. Andrews, Mansfield, Conn.

The vertical heddle levers are provided with oval openings above their fulcra. Eccentrics work in these openings and vibrate said levers. The eccentrics are each provided with a pinion on one side which meshes the teeth of the jacks or rack bars. These are reciprocated by the lifters or depressers, which are operated in the usual manner. The jacks are under control of a pattern machine.

192,986. MANUFACTURE OF BRICKS. Jacob Greenwalt, Pittsburg, and J. C. Anderson, Alleghany, Pa.

The clay having been deprived of moisture is compacted into the moulds by means of wedge-shaped plungers, operating from its opposite sides, thereby forming a light brick of net work form.

193,004. CIRCULAR SAW MOUNTINGS. Orrin L. Jenks, Port Huron, Mich.

Water is introduced through a journal box into grooves in the gauge collars and saws, and is then distributed upon the surfaces of the saws near the centre in a thin film. The relative spaces between the saws are adjusted, and the saws prevented from buckling by means of pivoted and laterally adjustable arms having wooden guide pins.

193,027. HOISTING MACHINES. N. P. Otis, Yonkers, N. Y.

As the engine piston ascends it carries with it the piston in the fluid retarder, forcing the water out through a pipe at the upper end, and against a piston, to which is attached a rod connected to the main valve which regulates the amount of steam required. The water displaced by the piston flows to the other side thereof, and arrests the descent of the car or cage should any of the machinery break.

193,028. LEATHER SKIVING MACHINE. C. F. Packard, Brocktown, Mass.

The invention consists of a rotary cutting cylinder, a reciprocating counter blank carrier, having a recess of varying depth to receive the blank, and mechanism for clamping the blank in place.

193,031. MACHINES FOR POLISHING THE EYES OF NEEDLES. A. E. Payne and J. S George, Bridgeport, Conn.

The box to which the thread clamp is attached reciprocates in the slot of a lever provided with a handle, which can be oscillated upon its pivot to cause the threads to round and polish the corners of the eyes of the needles. The clamp for holding the needles can be raised and lowered, with relation to the thread clamp, by a screw, in virtue of which the machine can be made to polish the eyes of either long or short needles.

193,043. PUMP. A. M. Scarles. Genesso, Ill.

The barrel of the pump is cylindrical in form, open at its upper and lower ends, and is cast in one piece with the valve box. The ports are in the sides of said box, which is secured to the side of a wooden pipe by means of straps and lugs.

193,056. DELIVERY APPARATUS FOR PRINTING MACHINES. S. D. Tucker, New York.

From the perforator of a perfecting printing machine, endless tapes carry the web over a guide roller, where the sheets are torn off. They are thence delivered over a fixed guide to a cylinder, on which a determined number of sheets, supported and directed by tapes and guides, are collected, and then by a rocking switch together discharged before an oscillating fly.

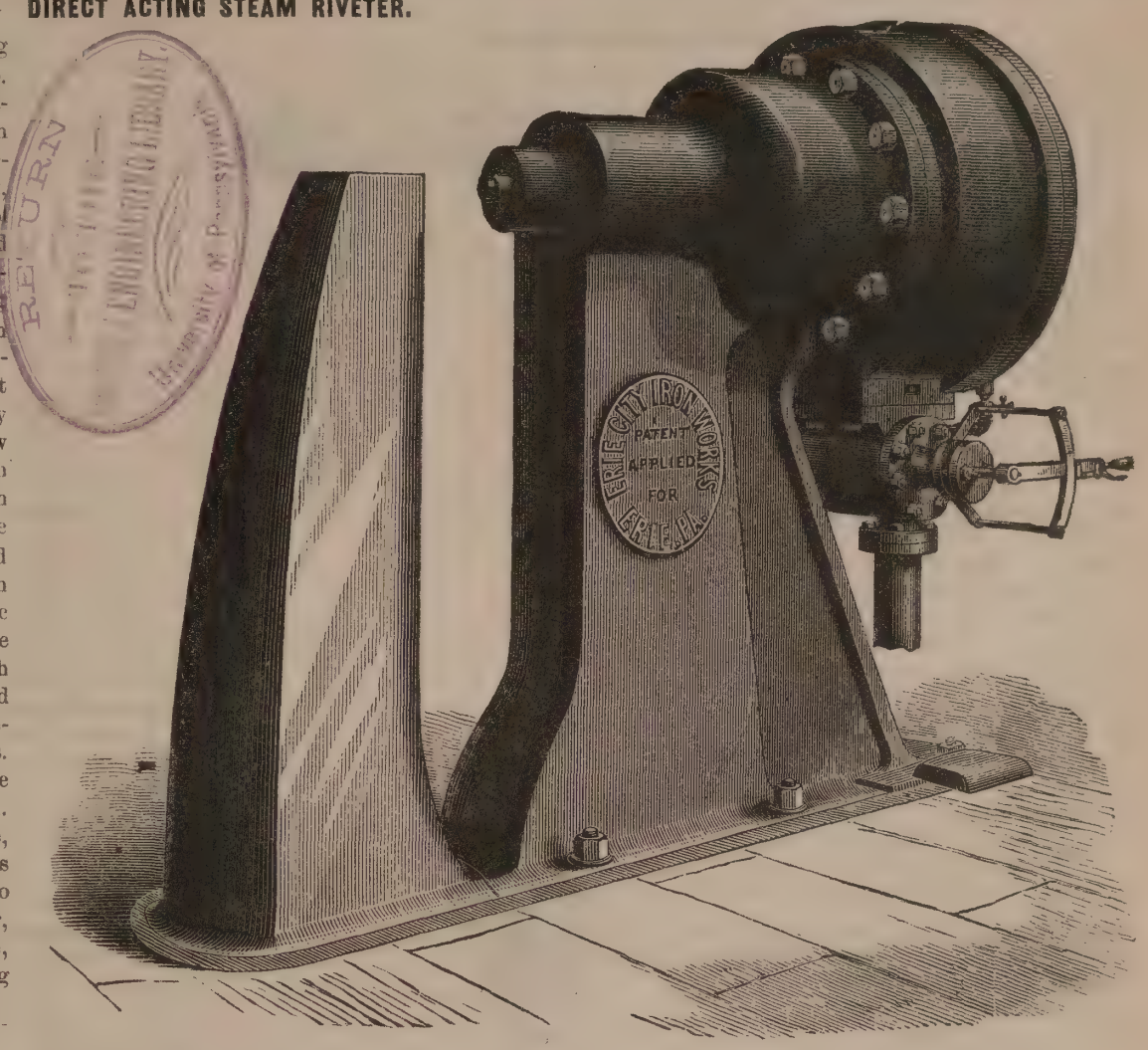
THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, AUGUST 18, 1877. NO. 7.

DIRECT ACTING STEAM RIVETER.



There was a time when the punch, shears, and plate bending rolls were the sole labor-saving machinery in the boiler shop. Now, however, there are at the disposal of the boiler maker machines for scarfing, flanging and riveting; and their work is both better and cheaper than that done by hand. We illustrate herewith a steam riveting machine,* which, especially in heavy work, produces closer contact of the plates and more thorough filling of the hole by the shank of the rivet than is possible with hand work; while as the process of forming the head in machine riveting is one of gathering together instead of flattening and spreading the fibres of the rivet, the heading is stronger and better than hand work. The theory and practice of riveting having been discussed at such length in our last number, we will at present simply describe the machine herewith illustrated. The main body of the machine is a standard stoutly braced and extending below the floor over five feet, to receive the heavy post or "man," which is fitted to its front side, and held by bolts and a wrought iron band (shrunk on) around the whole machine. To the opposite side of the standard are bolted the steam cylinder and the valve, and the top of the standard forms the guide for the piston-rod, which is eight inches in diameter, and acts directly as the ram. In the end of this rod or ram, and also in the top of the stake or man, are three holes for the reception of dies. The dies are of steel, with countersinks of the shape of the rivet heads, and are usually placed in the centre holes, although for cornering (as in locomotive fireboxes, etc.) they are placed in one or the other of the side holes. This arrangement also permits riveting a head to a shell, or angle iron to a plate. The valve is balanced and is worked by hand. The work is suspended by a swivel and chain, and being in place, a light quick blow is struck, to set up the rivet and bring the plates together; then a slow crushing blow is delivered and allowed to remain an instant upon the rivet. As the piston is 36″ diameter, 50 lbs. steam will produce $(36^2 \times .7854 \times 50) = 50{,}893$ lbs. pressure, enabling much heavier work than by hand, while avoiding crystallization of the rivet, and working much faster. G.

* Made by the Erie City Iron Works, Erie, Pa.

THE UTILIZATION OF BLAST FURNACE SLAG.

This material, which is a necessary waste product of the process of manufacturing iron, is a source of no little inconvenience and expense to iron masters, who, despite the exercise of much ingenuity, are frequently at a loss to know what disposition to make of material which accumulates with such rapidity as to render it a positive nuisance. The chief practical use that has been made of it heretofore, and that only in comparatively trifling quantities, has been to crush it into fragments of suitable size for roadbeds, for macadamizing roadways or ballasting railways, while the enormous excess, dumped into the hollows or adorning the hillsides surrounding the furnaces, becomes as characteristic and equally unpicturesque a feature of the landscape of the iron working districts, as are the mountains of slack coal about the collieries of the coal regions. That this material has not long since been made to serve more useful purposes, is not to be attributed to its want of useful qualities, since it is susceptible of numerous and important applications, which in time will possibly be so far appreciated that iron masters will come to regard the slag, that now causes them such annoyance and expense to rid themselves of, as a source of revenue, and to provide the plant for its conversion into marketable products in connection with their furnaces. That these opinions are not exaggerated will appear from the following brief resumé of the more important of the useful applications of slag that have, from time to time, been suggested, and which in certain localities, where economical conditions may be supposed to be especially favorable, have been carried into practical operation with more or less success. The following enumeration will serve to show that inventors have considerable faith that this material possesses eminent capabilities of usefulness. These suggested uses are quite numerous. For example, it has been proposed to cast it, in imitation of stone, directly into paving and building bricks, blocks, slabs and pipes; or to color it before casting, for making it into decorative tiles and columns to imitate marble and other precious decorative stones; or shaping it into architectural ornaments of black obsidian; to pulverize it into cement; to granulate or pulverize it as a material for building sand, or as the basis of a roofing material; and to blow it, by means of a steam jet, into the condition of a fine wool, for coating steam pipes, boilers, or for general uses as a non-conducting material.

Some of these suggestions have been practically tried and abandoned, more possibly because they failed to be remunerative, than from the adaptability of the material; so that at the present time, by far the greater part of the slag produced is not only quite valueless, but the iron smelter is obliged to pay for its removal. One of the most promising of these suggestions is to utilize slag for making building and paving blocks, which can be accomplished very cheaply and expeditiously, as may be inferred by a reading of the following description of one of the plans proposed for this purpose.

The slag is run directly from the furnace into moulds of the desired size and shape, which are fixed upon a rotary frame, so arranged that as fast as one mould is filled, another presents itself to the stream. The moulds are opened while the blocks are still red hot, and the latter are placed in a furnace or kiln close at hand, where they are annealed for about four hours. This constitutes the entire process, by which it is affirmed, two men and two boys are able to convert 30 tons of slag per day into paving and building blocks. As to the quality of the product, it is stated that the blocks thus prepared may be advantageously used for every purpose where bricks are commonly used. They are extremely hard, so much so as to turn a chisel, impervious to moisture and consequently to frost; the fracture is very close and firm, and they are capable of resisting an intense heat. They will stand a crushing force of three or four tons per cubic inch (vastly more than bricks.)

When they are used as paving blocks, the wearing surface is chamfered to afford ease of foothold to horses. The slag paving blocks are generally believed to be liable to the objection that they are too brittle, and hence liable to fracture from the effects of a sudden blow. It is not improbable, however, that by a proper annealing of the blocks, as described above, this difficulty may be practically overcome.

The following ingenious process of utilizing slag is said to be practiced in Germany.* The high furnaces are provided with a continual overflow for the slag, which runs through a narrow gutter, formed in the sand, into a shallow pit. Through this a small stream of water is kept constantly running, by the chilling action of which the molten slag is granulated to the appearance of a fine gravel. An endless chain lifts the granulated slag out of the pit, and loads it upon cars, which convey it to a cement mill, where it is converted into an excellent sharp building sand. The great bulk of it, however, without further reduction of its grain, is utilized for making bricks, by the following process. It is mixed with about half its bulk of mortar, in a suitable mixing machine, then passed through brick machines, which turn out the mass into the form of bricks with great rapidity. These bricks are piled up in the air to dry, and after about six weeks exposure are ready for use. They are said to

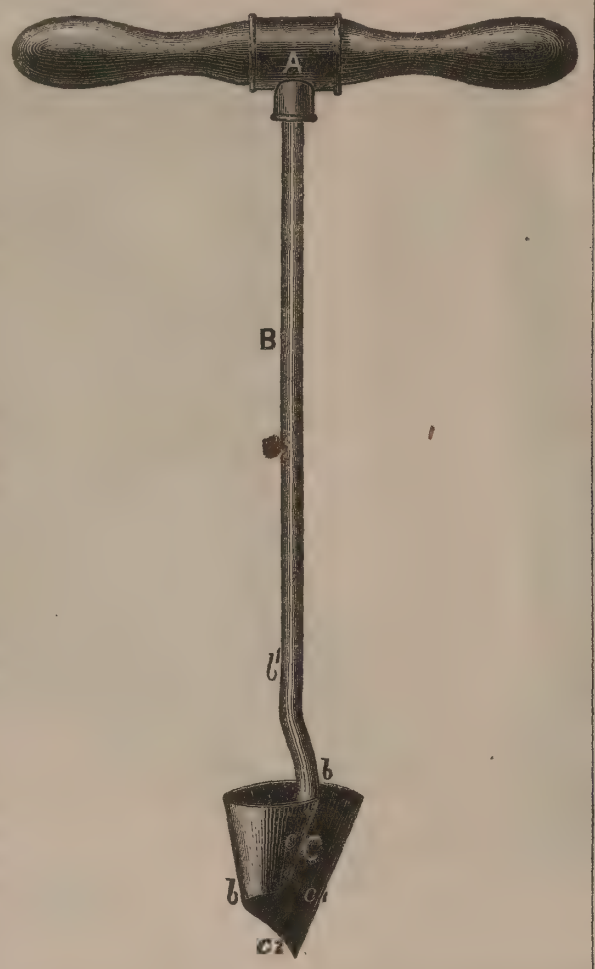
*Georg-Marien Huette, Osnabrueck.

continue to harden in the air for a considerable time, and to possess greater strength than ordinary bricks. They are reported to be extensively in use for all kinds of buildings, and to be quite popular by reason of their cheapness, durability and pleasing color. The roughness of their surfaces is also advantageous in retaining the rough cast coating so generally used in Germany for the exterior of buildings.*

Slag granulated by sudden cooling in cold water, has also been suggested and practically employed, as the basis of a roofing material, with certain plastic materials to give consistency to the covering, a detailed description of which may follow in a subsequent issue, in which we will discuss the application of this material in the production of the cheaper varieties of glass and in the manufacture of the curious substance known as slag-wool, used as an incombustible non-conductor. W.

IMPROVEMENT IN EARTH-AUGERS.

(Patented August 8, 1876, by William Poole, of Hume, N. Y.)



The object is to produce a conical-bladed auger for boring into earth, the same being provided with a shank, which is connected to this blade, and is bent so as to have its upper part in the line of the axis of said blade, thereby facilitating the removal of the earth, and allowing the bore to be made vertical. *A* designates the lever-handle of an earth-auger; *B*, the shank secured thereto; and *C*, the blade, secured to the lower end of said shank by one edge, *c*. The blade *C* is curled around somewhat like a scroll, with its cutting-edge c^1 a little outside of the edge *c*, and near thereto, so as to leave a space between them for the earth to enter the interior of said blade. The blade *C* is shaped like a frustum of an inverted cone, and has a downwardly-extending lip, c^2, which makes the first excision at the bottom of the cutting. It is claimed that the conoidal shape of the blade allows it to retain and bring up a greater quantity of loose earth than would otherwise be possible. The shank *B* is curved in its lower part at *b*, so that its straight upper part *b'* is in the line of the axis of blade *C*.

The inventor claims that this construction enables the cutting to be made quite vertical, with little strain on either the device or the arms of the operator, which would not be possible if the shank rose vertically from one side of the blade, and that it also leaves a larger space for the reception of the earth than if the shank were extended into the centre of the conical blade, and one of the edges of said blade were curled or bent into it for attachment.

LEAD AND ITS USES.

Lead has been known and employed in the arts from the earliest times. It is found native, but very rarely and in small quantities. Its commonest ore is the sulphide, called galena, from which most of the lead of commerce is obtained. This mineral is very extensively distributed, occurring in almost every quarter of the world. It occurs in beds and veins, both in crystalline and sedimentary rocks, and is often associated with zinc blende, iron and copper pyrites, the carbonate and other ores of lead, or with a gangue of heavy spar, calcite, or quartz. The most notable occurrences of galena are at Freiberg, in Saxony, where it occupies veins in gneiss; in Spain, in the granite hills of Linares, in Catalonia, Grenada and elsewhere; at Clausthal and Neudorf in the Hartz, and at Przibram in Bohemia and in Styria it occupies veins or beds in clay slate; in Derbyshire, Cumberland and the northern districts of England, rich deposits occur in limestone. It occurs also extensively in several localities in Silesia, in Algeria, in Australia, and at the Cape of Good Hope.

In the United States enormous deposits occur in Missouri, Illinois, Iowa and Wisconsin, which are extensively worked and have yielded large supplies of metal. And equally rich are the argentiferous galenas of the States and territories beyond the Rocky Mountains, which support mining operations upon a scale of unparalleled magnitude.

The reduction of the metal is effected by heating with exposure to air (or roasting), the sulphide, by which much of the sulphur is burned out, and a fusible mixture of oxide and sulphate of lead is formed. Fresh portions of ore coming in contact with this mixture, intract in such a manner as to effect the production of metallic lead by union of the sulphur with the oxygen contained in the compound.

Galena almost always contains a certain (often very large) percentage of sulphide of silver (argentiferous galena), and when this percentage is sufficiently high to make it profitable, which can readily be ascertained by assay, the silver is extracted by a process of refining.

Pure metallic lead has a peculiar blue gray color, and a high metallic lustre; when heated to the melting point (612° Fahr.) and slowly cooled, it is very soft, but becomes harder the higher it is heated and the more rapidly it is cooled. Its specific gravity is 11.33, and is not increased by hammering. Its tensile strength is very low, being, according to Trautwine, 1800-3300 lbs. per 9 square inches.

In solidifying from the liquid state it shrinks somewhat, so that castings made from it are never quite perfect. Its extreme softness is indicated by its leaving a greyish streak upon paper; it is very malleable, but not very ductile. Its specific heat (Regnault) is 0.0306. It is comparatively a poor conductor of heat,—its conductivity being represented by 179.6, with gold at 1000. Its electrical conductivity is even less, being represented by 82.45, silver wire being taken at 1000.

Lead does not readily oxidize; its surface soon tarnishes on exposure to air, but the thin film of oxide formed thereon appears to effectually protect the mass of the metal from further change. Rain (or soft) water cannot safely be kept in leaden cisterns, or passed through leaden service pipes, as the dissolved oxygen speedily gives rise to the formation of a hydrated oxide, of which a considerable quantity is soluble in pure water, and is highly poisonous. A minute quantity of any carbonate or sulphate, which spring and river water usually contains in the form of bi-carbonate or sulphate of lime, arrests the corrosion of the lead by the formation of an insoluble film of carbonate or sulphate of lead. If ammonia salts are present, however, at the same time, this protective influence is lost, and the solution of lead takes place rapidly. This fact is of considerable importance in connection with the very extensive employment of lead service pipes for the distribution of drinking water.

Diluted nitric acid is the best solvent for lead, attacking it with great energy. Sulphuric and hydrochloric acid attack it very slightly, owing to the immediate formation of a sulphate or chloride which tenaciously adheres to the surface of the metal, preventing further corrosion.

Lead is very largely employed in the arts, especially in the form of sheets and pipes. The process of manufacturing these products is highly interesting and has been described in a special article, pp. 49-50. The indifference of lead to the action of sulphuric acid has caused the employment of sheet lead in the construction of the chambers for collecting this acid in the process of its manufacture. Thinner sheets, in form of lead foil, are largely employed either pure or adulterating tin foil, in packing articles of food and for various other uses.

The use of lead pipe (the process of making which has been described in a previous article), for distributing water and gas is, one may say, almost universal. Its cheapness, admirable flexibility. ease of working, making joints, &c., rendering it vastly more convenient for these uses than pipes of any other metal. The circumstances under which lead pipes are rendered objectionable on sanitary reasons, as water conduits have already been indicated, and have given rise to the invention of processes for lining them with tin to render them harmless.

Lead wire has very slight cohesion, and is not largely used. It is useful, however, for attaching objects in cellars and damp places generally, because of its superior qualities in resisting oxidation.

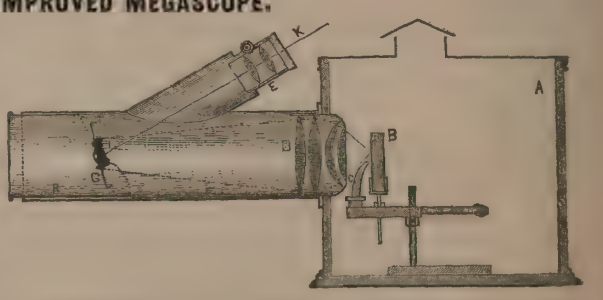
Lead shot is made of lead to which from ½ to ¾ of a per cent. of arsenic has been added, this addition being for the purpose of preserving the spherical form of the shot. The process is conducted in tall buildings, called shot towers, and the melted metal is allowed to pass through sieves of various sizes of mesh, and to fall for a considerable height (say 150 feet) into water. The size of the shot will depend of course on the size of the sieve meshes.

The alloys of lead are numerous and important. Its affinity for alloying with silver and gold has long been utilized for separating, by cupellation, gold and silver from the other metals and earths which accompany them. Alloys of tin and lead, in various proportions, constitute the soft solders, so much used for metals which melt at low temperatures. The so-called fusible metals are generally alloys of lead with bismuth and tin.

Pewter is generally composed of 4 parts of tin to 1 of lead; and many white alloys used in the arts contain lead alloyed with tin, zinc, copper or antimony. It is the base of all compositions for type metal. Generally speaking, type metal is composed of lead alloyed with antimony, to give it hardness and expansion in cooling, so that the mould may be filled. The composition of these alloys varies somewhat, according as the metal is to be used for printers' type, stereotype, &c. Lead has also been found a useful addition to art bronzes.

Of the compounds of this metal the most important are the proto-sesquioxide, called red lead, and of the salts the carbonate and acetate. The process of manufacture and uses of one or more of these may form the topic of a future article. W.

IMPROVED MEGASCOPE.



The cut shows a convenient form of megascope devised by Mr. J. B. Knight, Secretary of the Franklin Institute, to show upon the screen small solid objects used in illustrating the lectures at that institute. *A* is the box of the stereopticon; *B*, the lime, and C, the jet. *F* is the condenser tube, in which slides a removable tube, *R*, closed at the outer end and bearing a swinging platform, *G*, which receives the object to be projected The rays reflected from the object pass upwards and backwards through the diagonal tube in which slides the adjusting tube, *E*. By means of this instrument very small opaque openings of minerals, etc., may be projected very clearly and with great convenience. G.

* Bricks made from granulated slag and mortar at George-Marien Huette: Size: 250 x 120 x 65 mm.—in 1866, 345,200; in 1875, 6 534,000; total up to 1876 (inclusive) 29½ million bricks. 5 brick presses can turn out somewhat over 30,000 bricks per day, and use up per day over 100 tons of granulated slag.

The Polytechnic Review:

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

THE MANUFACTURE OF STEEL PENS.

The name "pen," derived from the Latin *penna*, a feather, is now a misnomer; as the once familiar "gray goose quill" has passed into history and symbolism. The first step of progress from the oft-mended quill with fringed top, was the making of separate pens from the barrel of the quill, to be used in a "holder." From this the transition to a metal pen was a bold one, as the fine sharp pocket-knife, called a "pen-knife" from its most frequent usage, would not form the metal pen, and machinery had to be designed and made to produce the new invention. We will pass over the early history of the steel pen and consider the processes which are involved in its manufacture.

In the first place, the *desiderata* of a steel pen are that its point shall be fine enough to make a hair line and hard enough to resist rough usage, and yet not sharp enough to penetrate or scratch the paper. The pen must be stiff enough to bear constant pressure, and elastic enough to open out and make a broad line. It must permit a certain amount of ink to flow down to the point only when the point is touched to paper, and must supply a larger amount at once when the wide line is required, without letting a "blob" of ink drop. It must resist in part the corrosive action of the inks in common use. Each one of a kind must be exactly like its million fellows, so that once suited, a penman can always be satisfied. All this requires fine machinery and material, and great skill to effect. For a long time we depended on England and France for our pens. Now, after repeated failure of many firms to introduce the manufacture and produce good work, one company* has succeeded in doing both.

The following description of the manufacture as carried on at this establishment, should prove interesting to our readers.

The steel employed is of the finest quality, and comes from Sheffield, England, in sheets 60×18 inches, $\frac{1}{16}$ inch thick. These are cut into strips from 2 to $3\frac{1}{2}$ inches wide, which are luted up in iron pots and put in an enclosed furnace, the "muffle." By being heated, the temper is drawn, and before being rolled it requires merely to be "pickled" suitably to remove scale, dirt, etc. The rolls (of which there are five sets, driven by a 50-horse engine) draw out the strips into lengths of from three to four feet, of the exact thickness required for a pen. The rolls require to be kept cool by streams of water.

From these long strips, screw presses, operated by girls, strike out the flat blanks. Other presses then cut the pierce-holes and the side slits, the blanks being guided by girls, and each kind requiring separate dies.

The flat and pierced pens (or blanks) are then returned to the pots and muffle and heated, then allowed to cool slowly or "anneal." In the marking shop they are next stamped by steel dies, with the name of the manufacturers, "R. ESTERBROOK & CO.," and the name and number of the pen, as "048 FALCON," "444 SCHOOL PEN," etc.

They are next struck up or "raised" one at a time, by lever presses, into the proper curved form; some grades, as the "Falcon," receiving a transverse buckle or corrugation claimed to give both stiffness and elasticity.

Hardening and tempering is next in order. This is effected in sheet iron cylinders (revolving slowly, so as to maintain uniformity of temperature) over a mild but even fire. The spring temper being attained, the pens are next revolved in galvanized iron cylinders with a polishing material, and when smooth and bright are ground, one by one, on very fine emery wheels, first lengthwise on the back of the point, and then crosswise. But all this time the pen has lacked the most essential characteristic, the centre slit—which must be central from the point to the pierce-hole, must have no "kerf" removed, and must have its sides and edges perfectly smooth, so as not to "catch" and "splutter." The tools which cuts these slits, one at a time, is accurate and rapid in operation, and will split a hair as well as the best Philadelphia lawyer. Now comes the ordeal—for the fiery experiences heretofore have not been ordeals but helpful processes to enable the pens to bear the operations performed upon them by the presses and emery wheels. The ordeal is a cold-blooded one. Expert examiners take up each pen, one with each hand and try the points, examine the marking, stamping, grinding, finish, temper and general appearance, throwing out a pen if the slightest defect be observable. For the customer—you, for instance, reader—who would have endured the squeaking or sputtering of a quill pen, will allow of no imperfections in the steel one. Although there are twelve tests of imperfection, blemishes are detected with such marvelous dexterity (or *ambi*-dexterity) that each examiner will pick out a hundred gross of good pens per day. The polishing, bronzing and varnishing processes are next in succession.

Being returned to the warehouse they are reweighed (for counting is out of the question, and weighing is even more sure), and then bronzed if so desired, and varnished, to prevent rusting and to give a fine appearance. This varnishing is accomplished by putting them into a wire vessel and dipping them into varnish and then rapidly revolving the swinger, to throw off superfluous varnish and partially dry them—an operation continued by shaking them in a riddle and then by baking them about five minutes at a low temperature. In the boxing department they are weighed into gross boxes and shipped. We are glad to note that shipments are not only made to all parts of this country, but to Canada, South America, Mexico, Cuba, and even *to England*—"carrying coals to Newcastle." The works employ about 200 hands—mostly girls, as being defter than boys or men. Each pen passes through from 20 to 25 distinct operations, many of which require special machinery and skilled operatives.

We would recommend our readers to pay a visit to this establishment (the leading one of the kind in the United States), where they will be kindly and courteously received and conducted through the works. G.

* The Esterbrook Steel Pen Manufacturing Co., Camden, N. J., to whose works we have lately paid a visit.

AN ADDRESS DELIVERED BEFORE THE MECHANICAL ENGINEERING ASSOCIATION OF CORNELL UNIVERSITY,

BY PROF. JOHN E. SWEET.

II.

If a steam engine fails to give off the power it ought, science at once points out wherein lies the defect. If a bridge or roof breaks down, science is generally not half as much puzzled in finding out why it failed, as in accounting for its not having failed before. In mechanical engineeering alone, science has done wonders in pointing out defects, more, perhaps, in pointing out the faults in the work of others than in designing faultless work of its own. In fact, faults, defects and failures may be looked for in all quarters in theory and practice. Inventions, designs, and workmanship are all liable to it. The man who does not make mistakes does not do much of anything, and the man who spends a lifetime in developing new devices is more liable to them than the one who follows in the footsteps of common practice. As mechanical inventions and engineering enterprises are generally judged by their commercial success rather than by their intrinsic merit, men often have the credit of being good mechanics, ingenious inventors, and first rate engineers, when the success is not due either to their ingenuity in inventing, skill in working, or ability in directing; but good inventions often contribute to the wrong man's glory, the public often swindled on a worthless patent, polish and green paint often are mistaken for workmanship; and fortunes often made in manufacturing establishments, not in the honest way, by devising better means than others have, which is engineering, but by using half-paid-for material, and doing the work at starvation prices. Fearing it may be inferred that I depreciate the importance of good business management, I will say that I do not believe that the best kind of shop management can keep up an establishment, except by the co operation of good management in the office. Neither do I believe that, either business financiering or scheming can very long keep up an establishment, if the work turned out is defective, dishonest, or sold under false pretenses. You are sure to have to deal with business men, more than likely to have to associate yourselves with them. Do not mistake a financier for a business man, do not take a man's ability to borrow as a gauge of either his ability or disposition to pay. Deal with the men that pay, and pay for your own deal. Pay your way as you go. If you owe your landlady for your board, and know not where the money is to come from to pay her, go hungry and go to work, and earn the money. If you are here trying to get an education either by begging or borrowing, go home and earn what money you need to carry you through. Artemus Ward's recommendation "to live within your means, if you have to borrow the money to do it with," was a first-rate joke, but if he had left off the last half, it would have been a good precept to follow.

In this matter of paying there is one thing that few men ever learn. If you owe a person, except in cases of special agreement, it is your business to take or convey to him his pay. If a person works for you the money earned is his, and it is not only your duty, but is it the best policy, to see that he is paid. It is the workman's duty to work without watching; it is the employer's duty to pay without asking, or as I have said to you before, there is no service so uncertain as that working for uncertain pay. In addition to good management in the office and in the shop, or perhaps rather to secure good management in both, the manager or managers need the ability to put the right man in the right place. The round man in the round hole, and the square man in the square hole. A square man in a round hole feels pinched on all sides, and with a round man in a square hole there is leakage at all corners. There is another matter which seems to be detrimental to business success, that is, the pretended secrets about an establishment. What great display of business tact there is in spending hundreds of dollars annually to keep people, often customers, from seeing what you are doing at home, and at the same time investing thousands of dollars in advertising to let people know what you are doing away from home, is more than I can see. The pretense that others in the same trade will steal one's ways and processes might have some weight, were it not for the fact that those who could profit in that way never find any difficulty in getting through rival establishments, while the customer may have the doors closed against him. A characteristic illustration of how the plan works in practice was when a proprietor kicked a student out of doors for inspecting his ordinary tools, while he was showing a rival manufacturer the beauties of his special machinery. Poor work or inventions of questionable merit may be palmed off by a glowing advertisement or a tonguey agent, while work of true merit sells itself, and the money often expended to sell poor work would more than have made the poor work good. Courteous treatment to customers and workmen, in fact to everybody, for it's hard to tell who may be customers and who workmen, is good policy. A man who feels kindly towards you is more likely to deal with you or do better for you than one who feels unkindly. Treat the boys kindly, for by the time you run for President they may be voters. All kinds of business have their disagreable features; and one of the most disagreeable connected with a manufacturer's business is that of having the clerk, who wears store clothes, sits in the office and smokes cigars, and keeps books for a change, assume superiority over the men who plan and execute the work. I have seen them where they would not admit that a ma-

chine possessed any value unless it appeared in dollars and cents on the books, and where because they kept an account of the money, they imagined they earned it, or made it. I believe there is an unjustifiable feeling of superiority, assumed and accredited to the man who performs nothing but mental drudgery, over the man who performs physical drudgery. In this do not understand me to mean men of originality and genius, for we mechanics can well content ourselves while we have Watt and Stephenson to stand side by side with Shakespeare and Dickens, and a Howe, Goodyear and Ericson for every Stowe. Hawthorne or Emerson. But what I mean is that I can not see wherein the man who works six hours in the office is better than the man who works ten hours in the shop —the man who has history, languages, and others' ideas pumped into him as water is into a barrel, and who holds them as a tight barrel holds water or lets them ooze out as water oozes out of a barrel (evaporating out of the bung hole rather than allowing it to be drawn out of the spigot), is superior to the man who labors faithfully to convert the dead materials of earth into the living, useful machine.

Why is the young man who spends forty weeks in the year in absorbing the contents of books and the rest of the year in idleness, who is supported by his father and waited upon by his mother, better than the young man who works faithfully at the forge, learns a trade, earns a living, helps his parents, and adds at least as much as a horseshoe nail to the value of the world.

Do not go away and say it appears that I do not approve of young men gaining the higher education, for I do—that is, those who have a natural talent, a fixed determination,and those who can afford it, but the point I wish to make is this, that however well a student may do, however faithful he may have been, however talented he may be, he is in no way justified in claiming superiority over any other young man who has performed his work faithfully until he has turned his education to such an account as to make his services of more value to the world than the laborer has his. It often seems to me that those people who are constantly harping about brains, over-estimate their value from the small stock they have to put on the market, or when a man sets a higher figure on routine clerical work than he does on skillful hand work, I am reminded of Silas Wegg, who demanded a higher fee for reading poetry than prose.

While I question the right of a man who has done nothing but store his mind with knowledge, to claim superiority over the man who has trained his head and hands in skill, I would grant to both, not only the right to claim, but give, whether they claimed it or not, the most liberal credit for all the useful results they achieve, either by their knowledge or by their skill.

These results are never attained but by those who take pride in their calling, and their greatest compensation is in the glory they receive.

Follow that business in which you can take a pride, and glory in your work. Certainly we should honor the minister who delivers in our chapel a good sermon filled with original thought, though it may last but for a day or a week, but why less the stone-cutter, who carved the corbells, filled too, with original thought, which may last from generation to generation, adding to their knowledge and pleasure. It is for such work only greater, that the names of Erwin and his daughter have come down to us since the building of Strasburg Cathedral, while half, at least, of their best educated neighbors have been forgotten. But, you may say, Erwin was an architect, and not a workman,—Oh, no. Erwin was a workman, one who loved his work, and put his soul in his work, and it was that which made him an architect.

All great men have worked out their own great works with their own skilful hands. Phidias carved on the pediment of the Parthenon, Michael Angelo handled his own mallet and chisel—Raphael his brush, Shakespeare wrote and played his own plays, Watt and Stephenson were both mechanics. They were all the great architects of their time. The leading civil and mechanical engineers are the real architects of to-day.

The talented students who are among the chosen few selected to entertain the audience packed in Library Hall this coming commencement, will take pride in their work as we will take pride in them. But why you who have worked so faithfully to help on our little display at the Centennial, which we hope and believe attracted the attention of half a nation, take less pride in your work? Equal pride, if the one adds as much to the value of the world as the other. I can well understand why the poet, standing in the centre of that old, old Roman temple could be inspired to say- -

What a grand old wall
Which circles 'round this sacred hall,
That's been domed o'er for ages;
Here priests and beggars can take their prey,
Poets and poverty have had their lay,
And Rome has laid her sages;
Shattered portico, time-worn front,
Cornice and columns with angles blunt,
Two minarets and dome,
Bronze doors—One eye,
Light from the sky,
Shines where the bones of Raphael lie,
In the Pantheon of Rome.

The work of the ancients was strong and beautiful, but always at rest. Ours are frail, perishable and full of life. Are they any the less artistic, any the less noble?

ABOUT FILES.

In using a new file, the pressure employed at first should be comparatively light until the very sharp edges of the teeth have been removed; after which, stronger pressure and deeper cut may be made without injury to the teeth. But if the teeth have hard usage put upon them while their edges are keen and penetrating, they are likely to take hold more strongly and become broken off at the root. A few careless strokes may damage a new file so as to take away half the "life" of the first cutting.

The skins of castings are not only "chilled," and hence harder than the interior, but are often glazed with a vitreous surface, in which, also, gritty particles are imbedded. No new file should be used on such surfaces, nor on welds where borax or vitreous fluxes have been used, nor on oxidized surfaces; but a worn file should be used to attack such work, which will scarcely harm it.

For filing steel, grades coarser than second cut are apt to be too "hoggish;" steel cannot be ripped off like brass or iron, and the same cut of file should not be used on steel and on iron, any more than on brass and iron or horn and iron.

In buying files, see that *full weight* is given, especially where recutting is to be done. While a light-weight file will hardly stand one recutting, one that is full weight will bear recutting two or three times. G.

THE GERMAN PATENT OFFICE, we learn from a reliable correspondent, received during the first month after the going into effect of the new patent law, no less than 3,000 applications for patents.

—The Scientific Society of Dickinson College, Carlisle, Pa., an active and useful organization, established in 1867, has published its history.

Ferd. de Lesseps

FERDINAND DE LESSEPS.

BY PROF. J. E. NOURSE.*

For a long term of years Lesseps was occupied in consular duties. He remained in Egypt until 1838, exercising the functions of consular pupil, then of vice-consul and consul-general. He had begun this service at Lisbon in 1825, following the fortunes of his family, different members of which have been at times thus employed.

While consul-general at Alexandria, Lesseps received the cross of the Legion of Honor for humane services rendered during the plague, which swept off one-third of the population. Transferred to Rotterdam, and then, in 1842, to Barcelona, he gave great satisfaction to the different nationalities in the latter place at the time of its bombardment by Espartero. The French residents struck a medal in his honor; the Marseilles chamber of commerce presented him with an address; the Barcelona chamber ordered his bust in marble; the princes of Sardinia and the two Sicilies conferred their insignia. In 1848 he was ambassador to the court of Madrid, and in 1849 represented his government at Rome. But here he voluntarily ended a career which offered high chance of political distinction. "Full of generous ardor and belief in human progress and the rights of man, he remonstrated against the occupation of Rome by French troops in 1849; and, after a protest against General Oudinot's bombardment and military rule, he retired from a diplomatic career in which advancement was so sure, thus seemingly sacrificing his whole future for principle." This estimate is in the words of our own former consul-general in Egypt, Mr. De Leon, who was with Lesseps at the time of his first proposing to Saeed Pasha the plan of the great enterprise at which we are now to glance. To do so intelligently let our readers look with us for a little while on the old land of the Pharaohs.

In the palmy days of that land its trade, if we may not call it commerce, was assuredly worthy of the age. According to Strabo and Herodotus, Pharaoh-Necho's ships passed from Arsinöe (Suez) out to the great ocean, hugging, it is true, its shores, but coasting Africa, and returning after voyages of three years to his Mediterranean ports. The well-known Scripture record in Kings and Chronicles is not without significant correspondence: "Once in three years came the navy of Tarshish, bringing gold and silver, ivory, apes and peacocks." Of the Egyptian seaports, Pelusium was long the queen. Its fortress was the key of Egypt and of the sea, and many a furious battle was waged around its walls. Here, in 525 B. C., Cambyses gained the victory which transferred Egypt to Persia. Herodotus tells us of the bleached skulls of the slain in that battle as attesting the distinctiveness of race. Alexander captured Pelusium B. C. 333; Augustus took it three centuries later; and after six centuries more Amroo received its submission as that of all Egypt.

Under the Roman rule the city was connected by famous military roads with Memphis and Suez, and with the cities of Persia. The Pelusiac branch of the Nile gave access to the old canal of the Pharaohs, which was available at a late day, since Cleopatra, after her defeat at Actium, meditated escaping with her fleet by this passage. In the year 697 the caliph Omar rejected the proposal of his lieutenant to open this canal and re-establish Pelusium. He feared the entrance of the Christians into Egypt and their interference with the pilgrims to Mecca. He forbade anything being done for Pelusium, which consequently disappeared from the eyes of trade and fell back into its primitive condition. The Arabs, in naming its ruins *Tineh*, have but perpetuated the original idea of the names given by the Hebrews, *Sin*, and by the Greeks, *Palos*—all meaning *ooze*, *mire*. The site of old Pelusium was indeed rarely again named until the time of Le Père's memoir.

To recover Peluse, and cut a new route for the commerce of our day straight across from sea to sea, became Lesseps' ruling idea on relinquishing his diplomatic career. Lesseps' idea was to bring the East close to Europe's door. He adopted for

* Abridged from *Lippincott's Magazine*, xiii, 332 et seq.]

his motto, "Aperire terram et dare pacem gentibus." He has steadily advocated the wisest extension of commerce, swift and close intercourse, and the civilization of Asia and Africa by this means. He has shown the most admirable faith, energy and perseverance in pursuing this object, and, having opened one highway, is projecting another of perhaps equal value to the world. On his recent election to the French Academy he presented, in place of a record of devotion to the abstract sciences, one of practical usefulness in the civil service of his country, and this brief but brilliant chronicle of the great ship-canal: "The first blow struck near Peluse for a new harbor on the Mediterranean shore, April 21, 1859; the canal of Suez opened for the world's commerce, November 17, 1869; declared an established success by the receipt of eighteen millions of francs during 1872." This was the triumph of an idea adopted forty years ago, and the result of a ten years' indefatigable struggle.

By what elements of character and by what help from the logic of events has he secured this? In the first place, he began with an intelligent but indomitable faith in the enterprise. His own words are, "J'ai pour principe, de commencer par avoir de la confiance." When addressing the chambers of commerce in different countries of Europe, meeting from time to time at public banquets the capitalists of England, Holland and France, visiting now Palmerston and Gladstone in England, and now the French emperor at Paris, or combatting the opposition of Sir Stratford de Redcliffe at the Ottoman Porte—even when the cholera decimated his laborers at Ismailia, or, worse yet, when the sultan's firman, obtained by British intrigue, called away every native workman sent by the pasha—he was ever buoyed up by the same strong assurance of ultimate success. His letters, speeches and despatches have not a tinge of despondency. In person he explored, often with extreme danger, the whole line of the temporary fresh-water canal constructed to supply first Suez and then the line of his workmen, and his main route. He visited every infected place to establish hospitals and sanitary rules. He came through all safe, as years before he had come safely off from the plague at Alexandria. He believed his work would be done, and that he would see it done. This was no small element of victory.

Another was the frankness with which he expounded his plan and courted investigation of its feasibility. At the outset he submitted the whole scheme first to the scientific engineers appointed by the pasha in 1855, and then to an international commission composed of the most eminent engineers of England, France and almost every other European state. They repaired to Egypt, went over the proposed route, and studied the topography of the valley of the Isthmus and of the Nile. They reported to the viceroy: "The direct canal from Suez to the Pelusian Gulf is the only solution of the problem of uniting the seas: its execution is easy, its success sure: its results to the world's commerce will be immense. Our conviction of this is without dissent." In thus inviting an impartial verdict, Lesseps acted very differently from those scheming companies in our day, who spread before the public only the inflated reports of their own engineers. From the first, and through all its ten years' progress, the work on the Suez Canal has been open to engineers from states and chambers of commerce that chose to investigate all its difficulties and bearings. The English engineer Hawkshaw, standing first in his profession, reported upon it in full to the viceroy in 1862.

His power of infusing some of his own enthusiasm into others enabled Lesseps, after other difficulties had been overcome, to raise with facility the necessary capital for the undertaking. Jerome Bonaparte, the comte de Chambord, and the duc de Montpensier were among the readiest subscribers after the viceroy of Egypt, who himself took nearly one-half of the shares. The mass of the remainder was thrown open to the people everywhere. Paris furnished seventy-three hundred stockholders, the departments, with Algeria, furnished thirteen thousand eight hundred, nearly three thousand of them holding but one or two shares each. The whole of the original capital was thus raised within fifteen days.

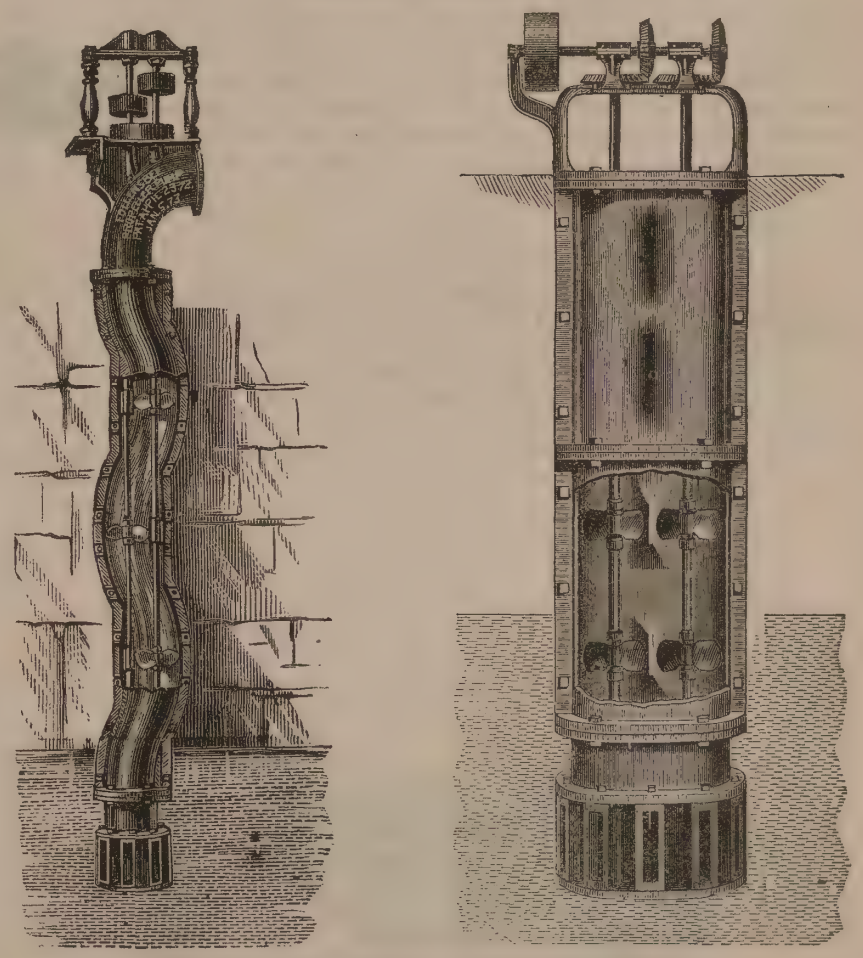
One circumstance not to be overlooked in connection with the enterprise is the great advance in engineering science within recent years, furnishing new appliances that proved to be absolutely necessary for the completion of the work. The ancients relied on the power of numbers for the execution of their vast and marvelous plans. The rulers of Egypt, in particular, had been accustomed to draw without stint on the enforced labor of the *fellahs*, and it was with a large body of these, detailed by the viceroy's authority, that Lesseps began his work. But the English Government procured a firman from the sultan forbidding their employment, and, "as was anticipated by those who opposed the project" (says the English captain Clerk, evidently referring to his own countrymen), "everything was brought to a standstill." After the loss of much time and money, laborers were attracted from France, Italy, Greece, and even Egypt. But the next year they were driven off by the cholera. Then necessity led to the invention of machinery equal to the work, bringing it, at reduced expense, to an earlier completion than if the myriads of old Egypt had been awakened for the task. The new steam-dredges, with their long iron spouts and buckets, drove the excavated mud of the cuttings two hundred mètres from their banks; while in the harbors machinery superior to that used in the construction of other breakwaters built out two arms or moles of more than two thousand yards with safety and despatch. Engineers from all countries repaired to Port Saeed to inspect them. Machinery was used representing the power of more than one hundred thousand men.

The canal is now writing its own history. It is fast revolutionizing the commerce of the Old World, and must sensibly affect our own. A route which lessens the distance to Bombay from English ports twenty-eight hundred miles, from Marseilles thirty-three hundred, and from the grain-market of Odessa four thousand, "must," as the English have lately admitted, "be kept open." The English press is, indeed, ashamed of such utterances as those of the *Examiner* of December, 1860, which called the canal "the monstrous folly of the nineteenth century, . . . never to be completed, or, if finished, to be exhibited as the *French folly*." The receipts of the enterprise during the last three years have increased in nearly geometrical proportions. Lesseps has his revenge for the obstacles and opposition he had to encounter in this heavy toll taken from our English cousins. Their own railroad from Cairo to Suez is abandoned: their travel and trade are along the new highway.

Before closing this brief notice of a remarkable man, we must not omit to mention the new project by which he is giving fresh proof of his lofty aims and indomitable energy. This is the construction of a railway to traverse Central Asia. Within ten days after he took his seat in the French Academy he laid before it his plan, and asked for the appointment of a commission to prepare instructions for a reconnoissance of the route. His son, Victor Lesseps, secretary of the French embassy to Russia, goes to sojourn at Peshawur, the head of the Indian railway system, to secure information of the caravans coming down from the Hindoo-Koosh Mountains. Before the Academy and before the Societé de Géographie of Paris, Lesseps has shown that as the whole distance from Calais to Calcutta is but seventy-five hundred miles, if Peshawur in India be joined with Orenburg, the terminus of the present railway systems in Eastern Russia, the traveler need be but a week in passing from London to Calcutta. It is not, however, certain that this particular line will be adhered to, Lesseps himself having since proposed a more northerly and circuitous route through Toorkestan.

Of course, this project has been already denounced by a portion of the English press, which, while admitting that M. de Lesseps' "audacity, *only* redeemed from the charge of folly by its affinity to genius" (!), has in the past triumphed over all opposition, and "effectually turned the tables on the skeptics and the scoffers," still warns the government and the nation against countenancing an enterprise which "is really part and parcel of the Russian scheme of Asiatic conquest." But the same organ which contains these denunciations admits that English capital will flow wherever the demand for it is backed by fair credit and the punctual payment of interest, and that Russia has hitherto met, and may still be expected to meet, these conditions.

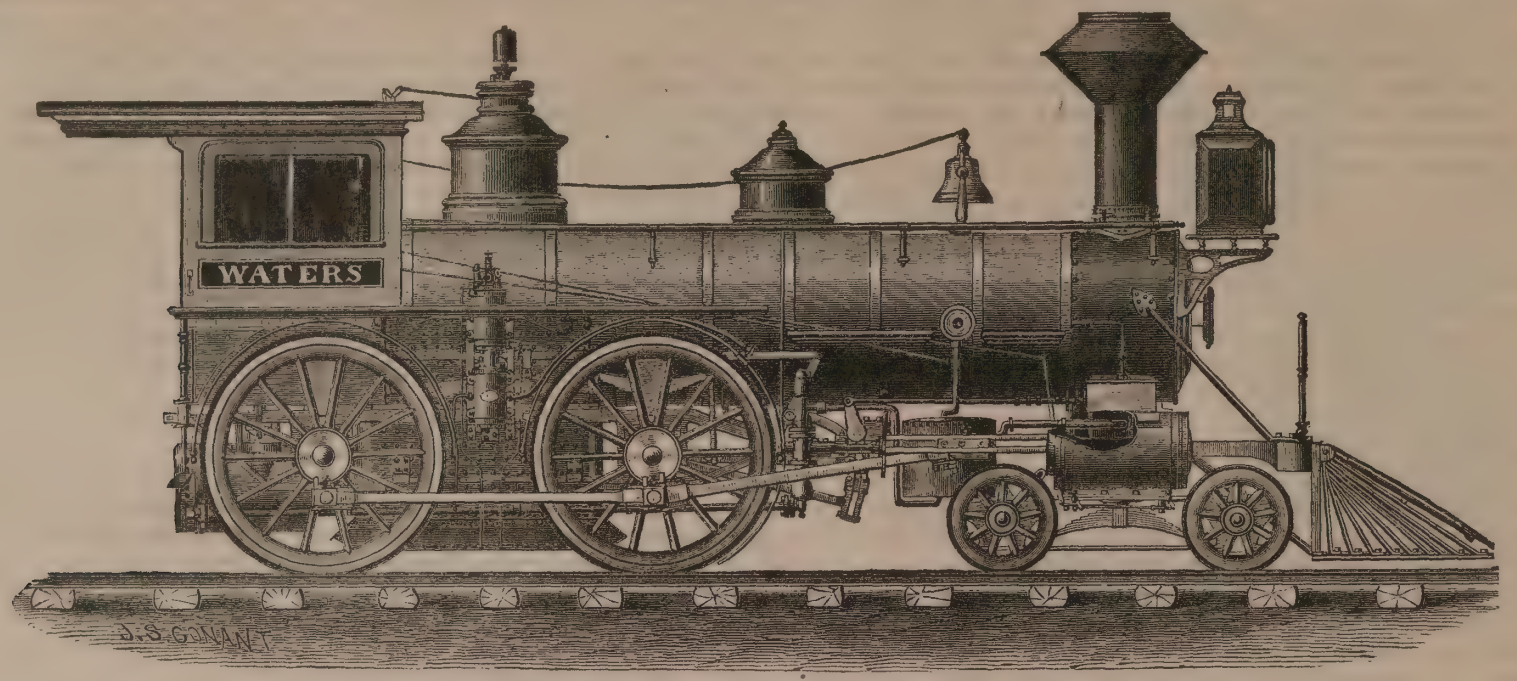
But it is more pleasant to turn from the narrow carpings of prejudiced critics to the enlightened grounds on which the project is supported by Lesseps himself. In his advocacy of it one cannot fail to admire the fairness with which he deals with the international questions concerned, and the expanded views he sets forth of the benefits to be conferred by these openings to civilization and freedom. He shows what hopes have already brightened for Africa and for Asia by the progressing renovation of Egypt, and predicts a still greater gain for the people of Eastern Asia from this new enterprise. Looking at his genius, faith, energy and indomitable perseverance in the past, we cannot but share in his anticipations, and trust that this grand undertaking will bring new renown to its projector and new benefits to the world.



THE FOLLANSBEE DOUBLE-PROPELLER PUMP.

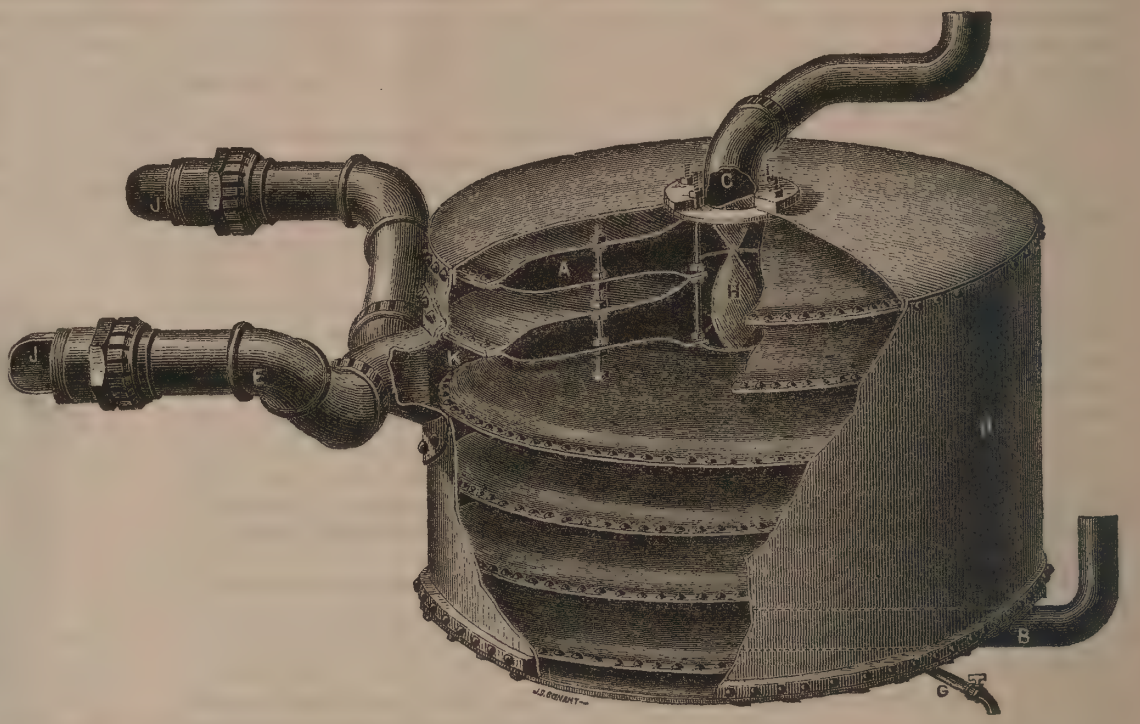
If a screw turns in a nut, either the screw must move longitudinally in one direction or the nut in the other, or both. If the screw and nut turn together, then neither advances longitudinally. In a ship propeller the screw advances much more than the water, which is the nut. If the propeller-screw be fixed, the water-nut will move longitudinally. In either case there is a loss of longitudinal motion, owing to the fact that the nut is not rigid, but turns with the screw, as well as being deformed thereby. The single-propeller pump has the advantage of having no valves, and requiring no "priming" to start it; but it must be rotated very rapidly, and this causes a centrifugal tendency in the water-column, leaving a hollow centre; while, also, this water-column *rotates* as well as advances. By using two screw-shafts as shown, these rotating in opposite directions, the centrifugal tendency is lessened and the rotary motion opposed, causing greater solidity and longitudinal motion of the water-column. The cuts show both straight and curved section double pumps. Tests made with these showed that when both propellers were used, no water escaped through a hole drilled in the side of the barrel; but with one propeller there was considerable escape. Two propellers threw a stream devoid of twist; with one only there was less than half the discharge, and quite a twirl in the stream. Such pumps would answer well for pumping semi-liquid substances, as mud, pulp, &c. The makers are the Follansbee Pump Company, No. 25 Kingston street, Boston.

G.

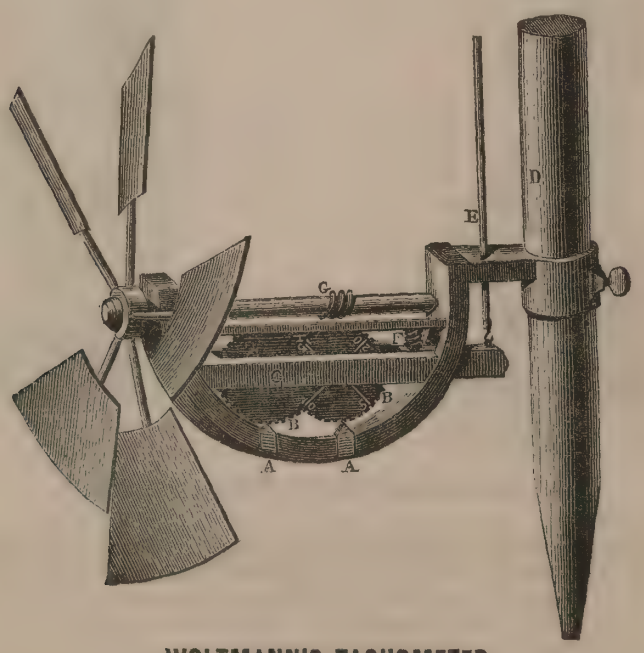


WATERS' FEED WATER HEATER FOR LOCOMOTIVES.

The cuts show a feed heater made by the Waters Locomotive Heater Co., West Meriden, Conn. There is a cylinder, *D*, with steel diaphragms riveted in pairs at their outer edges and having a large centre opening where the two adjacent plates of two pairs are bolted together by the long bolts, passing through the cylinder from end to end and having inside nuts which clamp the sheets together. *B* is the pipe leading from the pump to the cylinder, *A*; *C* being the pipe leading to the boiler. The exhaust steam is taken in by the spoon-shaped extension, *J*, and passed by the pipe, *E*, into the case, *D*. The water of condensation is drawn off at *G*. *H* is a spiral deflecting core to cause water circulation. The device is but 28 × 34 inches, but it contains 8,250 square inches of heating surface. As the exhaust is not returned to the boiler, there is some loss of effect; but again there is no opportunity for animal oil from the cylinder being sent into the boiler to damage it. The Old Colony Railroad has used these heaters over a year, and speaks of them very favorably, the stated saving in coal being 15 to 20 per cent. G.



AN HONORED AMERICAN.—A high honor has been conferred on America through George E. Waring, Jr., an engineer, by the Koninklijk Institut Van Ingenieurs of the Netherlands. Col. Waring has been made an honorary member on account of his services as a Centennial juror and his work entitled "A Farmer's Vocation."



WOLTMANN'S TACHOMETER.

The most successful of all the simple mechanical hydrometers, not requiring the assistance of an electric battery, has been the revolving mill introduced by Woltmann in 1790, and known as "Woltmann's Tachometer," or moulinet. This current meter has from two to five blades, either flat or like marine propeller blades set upon a horizontal shaft, as shown in the cut, which represents the entire instrument* in its actual magnitude for small canal and flume measures.

Upon the main axle, which carries the propeller, is a worm screw, *G*. A series of toothed wheels and pinions, with pointers and dials similar to the registering apparatus of a water or gas meter, are hung in a light frame, *C*, immediately beneath the main axle. One end of the frame is movable upward and downward, but when out of use is held down by a spring, *F*.

The whole instrument is secured by a set screw upon an iron rod, *D*, on which it may be set at any desired height.

When brought into practical use, the instrument is adjusted upon the rod,* so that when the staff rests upon the bottom, the main axle will be at the height of the film to be first measured. It is then placed in position with the propeller toward the approaching current. The propeller will soon acquire its due velocity of revolution from the moving current, when the movable end of the frame carrying the recording train is lifted by the wire, *E*, and the first tooth wheel brought into mesh with the worm screw.

If the train does not stand at zero, its reading is to be taken before the instrument is brought into position. The times when the train is brought into mesh with the worm screw, and when disengaged, are to be accurately noted and recorded. Upon the slacking of the wire, *E*, the spring, *F*, instantly throws the train out of mesh, and it is held fast by the stud, *A*, which engages between two teeth of the wheel. The instrument may then be raised, and the revolutions in the observed time read off.

In waters exceeding a few feet in depth there are usually pulsations of about a minute, more or less, intervals, and the instrument should be held in position until several of these have passed.

The velocities are thus measured at several heights on vertical centre lines in the several subsections, and the computations for the mean velocity and volume completed, as in the above described, when long tin tubes are used. The blades of the propeller are usually set at an angle of about 70°, or with an equivalent pitch if warped as a propeller blade.—*From Fanning's "Water Supply Engineering," published by Van Nostrand, N. Y.*

*Another form with two blades is illustrated in Stephenson's Canal and River Engineering, Edinburg, 1872, 101.

*Several moulinets upon the same staff at known heights between bottom and surface, expedite the work and tend to greater accuracy.

During the five months ending with May last, there were exported from this country to South America $325,225 worth of agricultural implements and machinery.

—A lead and zinc mining company has been organized in Crittenden county, Ky., with a cash capital of $300,000.

THE PAPER MANUFACTURE.

The antiquity of the paper manufacture is probably excelled by but few other products of civilization, Chinese historians carrying it back to a point far in the twilight of our history. In England it was first introduced near the close of the fifteenth century, and in this country in 1693, at Germantown, Pennsylvania. The materials from which paper is produced are numerous, but wholly of vegetable origin, neither wool nor hair possessing the capability of being reduced to fibrous pulp, a prerequisite to the formation of paper. Linen and cotton rags, straw, the leaves and stalks of the okra plant, jute stalks, manilla hemp, and even wood fibre, are all used in the manufacture of paper. No substance, however, can equal good linen rags, of which the toughest and finest paper is made. Next in rank are cotton rags, from which the best writing and note paper is made. In this manufacture great care is taken in the selection of the material and in every process.

Gathered from all parts of the country by tin-peddlers, and by peripatetic ragmen in cities, the rags arrive at the mill in bags, a portion of the stock, perhaps, coming in pressed bales from over the sea. The first process is sorting, and then the rags are cut, usually by girls, by means of a fixed blade in a bench, like a short upturned scythe, the operator picking them up by handfuls and drawing them over the edge of the blade. Each girl is furnished with a sandstone rifle, and when a large roomful of girls are at work, the sounds remind one strongly of a gang of mowers at work before the days of the mowing machine. A second sorting, for the removal of all buttons, hooks and eyes, and hard seams, follows, and the rags are then dusted. The duster is a large cylinder, the surface of which is of fine woven wire, inside of which is a shaft carrying arms set around it in a spiral form, and revolving at a higher rate of speed than the cylinder. This difference in speed gives the rags a thorough stirring, while the spiral arrangement of the blades facilitates the exit of the rags, which traverse the cylindrical sieve from end to end. White paper can be made from colored as well as white rags, and for the removal of the color as well as the dirt, they are submitted to a boiling with lime-water. The rags are placed in a large rotating boiler made of half-inch plate, mounted on journals and driven by proper gearing, as a worm and wheel. Through the hollow journal steam is admitted and kept at a pressure of from forty-five to sixty pounds, representing a heat of from 292° to 308°. Lime-water, in the proportion of about one part by weight to ten or twelve of the rags, is mixed with them, and the boiler is set in motion. Usually a charge requires from eight to twelve hours' boiling. Even this severe test does not fully purify the rags, which are next passed through an "engine." To the uninitiated a brief description of this apparatus is necessary. It is a tank of oval form, the walls or sides rising two and a half feet from the floor. This is partially divided lon gitudinally by a straight upright partition, not extending to the ends, however, but leaving a space between its ends and the tank's sides, of a width corresponding to that between the sides of the partition and those of the tank. On one side of this partition, across the centre of the tank, is a toothed drum, the teeth or blades of which alternate with fixed teeth at the bottom. These teeth tear the rags to tatters, but without destroying the fibre. A stream of water is constantly passing through the tank, and is constantly removed. This is done by a wheel of fine wire netting that revolves on the side opposite to the toothed drum, taking up the mass, but detaining the pulp, the water running off through the shaft of the wheel, which is hollow. Thus the water is used only while making a single passage around the tank, the current being produced and maintained by the rotary movement of the beater or tearer. The condition of the rag material when it comes from this cleansing engine is that of a coarse pulp, technically known as "half stuff," which is subsequently submitted to the action ot another engine, known as a beating engine, but essentially the same as the cleaning engine.

But still further cleansing is necessary. The material is next mixed with chloride of lime and again passed through the engine. It is then heaped upon drainers, and looks much like a mass of half-melted snow. The white, however, is a dead white, having no brilliancy. To receive this quality it must literally be colored. As the laundress blues her clothes to make them whiter, so must the paper stuff be blued, and when so tinted it has that same quality of whiteness as wind driven snow, which always shows a bluish tinge. This is quite different, however, from the blue writing-paper so affected by the fashionable twenty or thirty years ago, and now the favorite tint in the South and in England. That is really blue paper, while our usual white paper is merely tinted sufficiently to remove the dead, yellow, lustreless appearance of absolute whiteness. The bluing is ultramarine, as used in calico printing and for other manufacturing purposes, made from silicate of soda, alumina, sulphurets of iron, and carbonate of soda, and not from lapis-lazuli. This is mixed in powder with the half stuff just before the final beating.

After the final beating the material is apparently a thin, milky fluid, having no trace, to the unaided eye, of the fibrous character that it really possesses. Formerly the paper was formed by hand, the workman dipping a rectangular sieve into the fluid pulp, and depositing the sheet of pulp on a piece of felt to dry. But very little paper is made so now, the Fourdrinier machine having taken the place of the hand workman. This "machine," as it is called *par excellence*, is a wonderful production of skill; it is almost wholly automatic in action, and works with marvellous exactness. It is scarcely possible to describe it without detailed engravings, but a brief account of its work may aid in its comprehension. Some of these machines are not less than six feet wide and seventy-five feet long, requiring a building by itself, and making a sheet of paper over five feet in width. The pulp is pumped into an elevated tank, from which it is delivered to the machine through an adjustable gate opening from a reservoir. The amount of pulp fed to the machine regulates and determines the weight of the paper, and of course it must be governed absolutely and exactly, the speed of the machine being a constant. The pulp flows on to a roller, which deposits it on an endless apron of fine woven wire, which has a constantly jarring motion, tending to shake out the water and aid in the homogeneous union of the particles. Thick rubber straps on each side of the endless apron determine the width of the sheet. Passing between rollers which compress it, the sheet of pulp goes over perforated boxes from which the air is exhausted by a pump, and much of the remaining moisture is driven out by atmospheric pressure. A bath of liquid glue gives a proper sizing to the sheet after it is fully dried by cylinders heated by steam. The sheets, dampened by glue, are taken to a drying-room, from whence, all wrinkled, they are submitted to a calender consisting of a stand of rolls, three of chilled iron and two of paper. These latter are made of manilla paper cut in disks, with a hole for the axis or shaft, and compressed by hydraulic pressure. When turned and finished, these paper rolls are as smooth and almost as hard as iron, presenting a highly finished surface. The sheets are then trimmed by a machine suggestive of the guillotine, and ruled. The pens used on the ruling-machine are of peculiar form, made of sheet brass and fed with ink by a wick. Most of those used in this country are made by one concern in Harrisburg, Pennsylvania.

Book paper is made of old paper entirely. The processes are similar to those employed in making paper from rags, except that, owing to the more pliable nature of the material, they are not so long continued.

Jute is used for making coarse paper, such as is used extensively for flour-bags, for which it is well adapted, being very tenacious of fibre, a full-grown man having been carried by four persons each lifting a corner of a sheet of jute paper from which bags are made, designed to hold a quarter of a barrel of flour—49 pounds. The jute stalks come in lengths of from ten to fourteen inches. They are imported from Calcutta, and are the same material from which gunny cloth and gunny bags are made. The stalks pass through a rotary cut ter, with stationary knives and knives set in a cylinder, by which they are torn to coarse shreds. A boiling under steam pressure, in a rotary boiler, with lime, follows, when the mass is heaped and allowed to "sweat" a few days. It passes through the cleaning-engine, as do the rags described above, is bleached with chloride of lime and sized with a size made of rosin and washing-soda. The after machining is similar to that used on writing-paper.

Envelope paper and fine wrapping-papers are made from old manila rope, and paper for paper collars from cotton rags. In both cases the processes are of a similar character to those employed in the manufacture of paper for writing purposes. A necessary requisite for paper-making is pure water; so paper-mills are never found on the banks of sluggish streams or the shores of a marshy, muddy pond. The coloring matter for tints is introduced into the beating-engine when finishing the half stuff.

J. H. L.

THE INJECTOR.

The action of the injector, forcing water into a boiler against a pressure equal or even greater than that of its steam jet, may seem paradoxical. Yet it is simply based upon the natural law, that the "energy of a moving body" is equal to "its weight multiplied by the height due to its velocity." For fluids confined under pressure this height is simply equal to the pressure per square foot, divided by the weight of the fluid per cubic foot. In a boiler under 100 lbs. pressure it would be: for the steam $= \frac{100 \times 144}{0.2315} = 62.213$ feet; and for the water $= \frac{100 \times 144}{56.5} = 255$ feet; thus if the total energy of a jet of steam could be transmitted without loss to a stream of water, the former could hold in equilibrium a quantity of the latter $= \frac{62,213}{255} = 244$ times its own weight.

But the greater part of the energy in the steam jet is spent in heating the water, and only $\frac{1}{8}$ to $\frac{1}{12}$ is imparted to it as actual energy, while some is lost by radiation, etc. Practical experiments on this subject differ yet widely, but it may be stated that with one pound of steam an injector will feed from 20 to 30 lbs. of water into a boiler, when the pressures are equal. The number of foot-pounds exerted in forcing 31 lbs. of water (30 lbs. feed and 1 lb. condensed steam) into a boiler with 100 lbs. pressure per square inch, can be easily found.

To overcome friction in pipes, valves, etc., the pressure of the injected water must be somewhat above 100 lbs., say 105 lbs. per square inch, and 31 lbs. being $\frac{31}{62.5} = 0.496$ cubic feet, thus giving $0.496 \times 105 \times 144 = 7500$ foot-pounds per pound of steam—or (with an evaporation of 9 lbs. of water per 1 lb. of coal) 67,500 foot-pounds per lb. of coal. The duty of various pumping engines may be stated as follows:

Compound pumping engine for water works, 637,000 foot-pounds per lb. of coal.
Feed pump on steam engines 400,000 to 450,000 foot-pounds " "
Donkey feed pumps 100,000 to 150,000 foot-pounds " "

It will thus be seen that as an instrument for lifting water, the duty of the injector is very low, while as a combined feeder and heater it shows very favorably:

Total heat in one pound of steam of 100 lbs. pressure . . .	1214 units.	
Heat remaining after condensation	86·0	
Heat converted into work	$\frac{7500}{772} = 9.715$ units.	
Heat imparted to 30 lbs. of feed-water heating it from 50 to 86°	= 1080.	
Lost by radiation, etc	38.285°	
	1128.000	1128.0

Where the feed-water can be heated by the exhaust steam or by the gases escaping from the boiler flues, the amount of heat imparted by the injector is of no great account, and in such cases its advantages over a common feed-pump are only due to its simplicity, the absence of all moving parts and consequent saving in wear and repairs, its cheapness, facility of starting, directness of action, etc.

The universal application of injectors to locomotives and stationary engines seems to prove that these last named claims of superiority are really of some importance. An imperative necessity in the working of the injector is the instantaneous condensation of the steam jet, when it comes out of its nozzle to enter the water. To effect this, the incoming water should not exceed a certain temperature, and the level from which it flows would either have to be above the injector, or the latter should have a special appliance, to create a vacuum, and thus suck up the water. For the latter purpose some injectors have an auxiliary steam jet, generally opening into the overflow nozzle; this jet creates a vacuum in the water chamber, which sucks up the feed-water. When it is seen issuing from the overflow, the main steam valve is opened and as soon as it is fairly at work, the auxiliary steam is shut off.

A great number of patents has been taken out for improvement in injectors, and great progress has certainly been made in their construction and efficiency. In a future article some of the most important types now in use will be fully described and illustrated.

J. HAUG, M. E.

THE longest highway bridge in the State is soon to be built across the Des Moines river at Bonaparte, Van Buren Co., Iowa. It will be 900 feet long in six equal spans, and will be built of iron. The specifications submitted by the different bidders for this work, were referred for examination to Major Stickney, engineer in charge of the Government works at Keokuk, and L. M. Johnson, chief engineer of the K. & D. M. R. R. In accordance with their report the contract was awarded to the King Iron Bridge and Manufacturing Co., of Cleveland, Ohio.

PLATE GLASS.

Venice for many years surpassed all Europe in the manufacture of plate glass.

The Duke of Buckingham introduced it into England by the means of Venetian artists with great success; about the same year [1665] Colbert established a factory at Cherburg, Normandy, [France,] on the plan of a Venetian manufacturer. Up to that date the plates for mirrors were made by blowing, which was effected in the same manner and with the same tools as now exist in our window glass factories, some few modifications being necessary on account of the greater size of the cylinder. The beautiful art of casting was introduced in France in 1688, by Abriham Therart, [the inventor.] A company was soon established that afterwards removed to St. Gobin, where it still exists in full activity.

The composition of plate glass differs from ordinary glass only by the purity of the ingredients. The chemical composition being silicic acid, 72 ; soda, 17 ; lime, 6 ; oxide of iron, 2 ; alumina, 2.

The superiority of the French [St. Gobin] over the English is due to the fact that it is a true chemical compound, consisting of one atom of trisilicate of soda and one of trisilicate of lime. The English, on the contrary, is composed of two glasses of different densities.

I will not attempt to give any recipes for the manufacture of plate glass, as they differ greatly with the country and composition of the materials of which it is composed. In Germany potash is more used than in France and Belgium, where soda is preferred, both methods having their advantages potash giving less color. Soda gives the greater degree of fluidity and facilitates the fining and casting. Fusibility of the mass is obtained by the use of 1-15 or 1-24 of lime. It should be free from iron. This proportion, like all others, varies greatly according to the circumstance ; to say that a good glass is composed of a fixed number of pounds of sand, soda, etc,. is absurd. This amount must be determined by practical experience, and not depending upon the results obtained in France, Belgium, England. For example, a Belgian firm proposes to establish in Flushing County, Pa., a plate glass factory ; it would be absurd for one instant to suppose that Mr. Gobert, the engineer in charge expects to use our ingredients in exactly the same proportions as he did at St. Gobin.

Often glass has a yellow tinge, then a discolorizing matter is used [Manganese.]

When the sand is impure, it is of the highest importance that it should be washed, it is then dried in an annealing furnace for two hours. Why commence manufacturing plate glass where pure sand is not to be found ? This is frequently done from want of judgment. At St. Gobin the sand is placed cold in the pots.

The fitting, drying, melting, refining required some years ago different furnaces and pots, has now been greatly abandoned, and all is done in one operation.

The forms of these pots or "cuvettes" vary with the factory; some like them quadrangular, with sharp angles or rounded, whilst again the oval ones are preferred, the last, I think, are the best, as they take up less room in the furnace. They are exposed, on account of their shape, to a greater fatigue than the above, and for that reason should be made with great care their drying should last about six months.

Their contents should be as near as possible in volume to the quantity required for one casting—600 to 1,000 lbs. On their interior, near the middle of their height, a groove should be made to facilitate their removal with tongs from the furnace ; they are 12 in number in the best Siemens' gas furnaces, each being made the special charge of a workman.

They are placed in the furnace, which is gradually heated ; after an elapse of some hours, part of the ingredients are placed in the "cuvette." Broken glass is also added ; the quantity varies greatly with the heating power of the furnace. Afterwards another portion is added, etc., until they are all full. Attention should be given that an equal reduction should take place in all the pots at the same time [a little lime can be added if any retard is noticed.]

In 7 or 8 hours the glass is entirely melted, but it is full of small bubbles of gas [blistering would be the result if these bubbles are imperfectly cleared] and presents a spongy rather than a dense appearance. The fining, so called, now commences, the impurities, such as undissolved grains of sand, go to the bottom, and the gas bubbles rise and disperse on the surface. This is accomplished by increasing the intensity of the fire during 5 or 6 hours, at the end of this time the glass is perfectly transparent, but too liquid to be utilized for casting. It is allowed to remain in the "cuvette," during which time the temperature is reduced, the mass of glass then becomes thickly fluid. This glass remains at a temperature of 700 to 800 degrees C. during the rest of the manufacture. A furnace of 12 pots will furnish about 300 square feet of glass 3 inches thick. All the above operations require about twenty-four hours.

The molten mass is now ready for casting, which is one of the most interesting operations to the observer, and reminds one of the manœuvre of a large Krupp gun—each man at his post ready to receive orders from his chief.

The "cuvettes" are taken from the furnace by tongs on wheels, then placed on a small four wheel iron wagon and pulled rapidly under the crane, where a workman is waiting to remove the scum on the surface, he makes use of flat tools called swords, the "cuvette" is exteriorly cleaned and then taken up by the crane and swung over the casting table, this table is composed of a metal plate, made either of cast iron, copper or bronze, well polished and slightly warmed—this is done by sprinkling hot coals which are removed immediately before the casting is commenced. Their weight varies from 50 to 60,000 lbs., and cost considerably. These plates are on a level with the annealing furnace, and are fixed on a car that can move upon casters ; in this manner the plate can be placed in any particular cooling room.

The suspended "cuvette" is inclined, its contents fall opposite a bronze or cast iron roller [a small quantity still remains in the pot ; this is the impure substance] which passes over the surface on guides of the thickness required. From the time the glass is taken from the furnace until the plate is placed in the cooling room, 5 minutes have elapsed. The object of warming the plates is to prevent sudden cooling of the glass—the cooling rooms are at the same temperature as the plates, after the casting is finished, and are made air-tight as soon as full, they contain 6 plates,—after 24 hours a small quantity of air is permitted to enter, the workman then enters the oven to examine the result of the past operations. When a crack is visible it is stopped by placing a red hot iron at the point the crack ends.

The cooled glass plate is taken out of the annealing oven to the cutting room, where it is laid on a table covered with cloths, and there cut with a diamond to the required sizes.

The under side of the plate, that has been in contact with the casting table, is smooth, whilst the upper surface is wavy and require to be polished. For this operation, two plates are made use of, a small and a large one, the largest is fastened to a bench with plaster of Paris in a perfect horizontal position. The smaller plate is fixed into the muller, a moveable box, made heavy by weights. Coarse sand and water are applied ; the plates present opposite faces to each other, that is to say, rough towards smooth : the upper stone is set in motion and takes a backward and forward movement, done either by hand or by machinery. Finer sand is added after some little time, until the plates present a perfect horizontal and even surface. The finishing is done with leathern pads on which a small quantity of oxide of iron is placed.

Various machines are used for polishing, the first was invented by Mr Carillon, a French engineer who rendered great service in the manufacture of plate glass. The glass in the above operation is often reduced to one-half its thickness, this being a great loss to the manufacturer. Mr. Bessemer proposed, some few years ago, a method for casting plate glass in sheets. The idea was to pour the melted mass between rollers placed at a given distance from each other. The plate would then pass between two other finishing rollers, being rather closer together than the first. The results I have seen have never been equal to the ordinary casting. In England the manufacture of fluted glass has arrived at large proportions, it being 8,000 tons yearly. For green-houses it is much used ; prevents the sun from burning the plants as it does with ordinary thickness.

A few figures will show the importance of the importation to the United States for the year 1876 :

Plate glass.	Value.	Quantity in square feet.
Cast, polished, not silvered,	$1,358,401.00	1,592590.58
Rough, rolled, fluted,	35,736.00	899554.50
Total,	1,394,137.00	2,492145.08

Sizes varying from 10x15 to 24x60 and above.

LEWIS L. WARE.

Philadelphia, June 23, 1877.

[Copyrighted.]

SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

V.

PRACTICAL USE OF THE DIAGRAM.

The diagram explained in the foregoing can be applied in practice to any question relating to the construction of slide valves. The question simply resolves into the problem of drawing the diagram in accordance with the given data, and the sought dimensions or results can be taken from it. Beginners are advised to sketch a diagram of the general form and to mark in it those dimensions that are known or given. The execution of a drawing to scale will then offer no difficulty.

The diagram being drawn, it is easy to proportion the valve gear accordingly. The diameters of the "eccentric path Z" of the diagram represents the travel of the valve, and the throw of the eccentric has to be made to correspond. The proper dimensions of the valve can be found as shown in a previous chapter (width of ports) from the laps given by the diagram. If a valve thus proportioned is properly set, its operation will correspond with the indications of the diagram.

In setting a valve two things are to be taken into consideration : first, the length of the eccentric rod or of the valve stem, and second, the angular position of the eccentric on the crank-shaft. To accomplish the first point it is necessary that either the length of the eccentric rod or else that of the valve stem is made adjustable. It is an object to adjust this length with as few turns of crank shaft as possible, especially on large engines. To this end turn the eccentric until the valve stem is in one its extremest end-positions, say as far *towards* the crank-shaft as it will go. Then adjust the valve according to the greatest port-opening shown in the diagram, or, in other words set it so, that the distance of its outside edge from the outside edge of the respective steam-port (S in Fig. 1) is equal to the greatest port-opening of the diagram. This being done, set the crank on its dead centre with the piston nearest the crank-shaft, and, holding it firmly in this position, advance the eccentric until the proper port (S in Fig. 1) is opened by the valve to an extent equal to the lead required, and tighten it on the crank-shaft. If now the crank is turned on its other dead centre, the lead for that side will be found to slightly differ from the lead required, owing to the influence of the angularity of the eccentric rod, which, it will be remembered, we had omitted to consider until now.

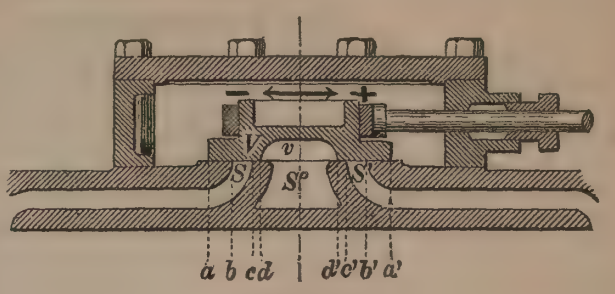


Fig. 1.

To correct this difference, the eccentric rod (or the valve rod, as the case may be) must be lengthened by one-half the difference observed ; the remaining half of this difference is subsequently removed by changing the position of the eccentric on the crank-shaft, care being taken that the crank remains on the dead centre to which it was adjusted last.

In this way the setting of the valve requires the crank to be set but once to each of its dead centres.

A later chapter will show that sometimes the lead of the fore-stroke is required to differ from that of the return-stroke. The given rule will be equally applicable for setting the valve in such a case.

In the following we shall leave out of consideration the influence of the obliquity of the connecting rod ; in other words, we shall consider the connecting rod to be infinitely long. The position of the piston corresponding to any one crank angle may therefore be found by drawing the crank-path to a reduced scale, and projecting the crank pin centre on its horizontal diameter or any other horizontal line. The crank-circle may sometimes be drawn to a scale to make it coincide with the path of the eccentric, as will be shown in some of the following problems.

Problem I. A small steam-engine of 7″ stroke is provided with a valve of $\frac{3}{8}$″ outside lap and $\frac{1}{16}$″ inside lap. The travel of the valve is $1\frac{1}{2}$″ and the lead is adjusted to $\frac{1}{16}$″. What will be the angular advance, how much expansion and cushioning will take place, when will the exhaust commence, and how much will the outer edge of the valve overrun the inner edge of the port if the width of the port is $\frac{5}{16}$″.

At first we sketch a diagram of the usual form (Fig. 13)

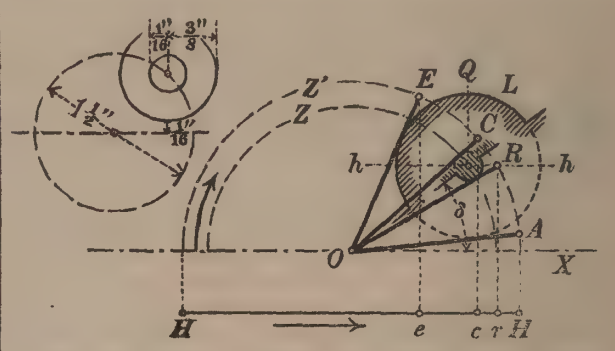


Fig 13.

and mark in it those dimensions which are known, and in referring to this sketch the course of construction will plainly be seen. The circle Z, representing the path of the eccentric, is given by its diameter, equal to the travel of the valve, and can at once be drawn. The lap-circle L should be $\frac{1}{16}$″ above the line OX, and its radius is known to be $\frac{3}{8}$″, hence its centre Q must be $\frac{7}{16}$″ above OX. A horizontal line $\frac{7}{16}$″ above OX will therefore intersect the circle Z in Q, and both lap circles may now be drawn. The crank-positions E, C, R and A, will respectively indicate the commencement of expansion, compression, release and admission. If we finally draw the crank-circle Z' at a reduced scale and project the crank-centres on the line HH, which represents the stroke of the piston, we find the cutting-off to take place at e, which is $4\frac{1}{8}$″ of the stroke. Cushioning commences at c and the release at r, respectively $\frac{7}{8}$″ and $\frac{1}{2}$″ before the termination of the stroke. The largest port-opening can be directly measured in the diagram and will be found to be $\frac{3}{8}$″ which is $\frac{1}{16}$″ above the width of the port. The angular advance is given by the angle δ. The point of admission is here and in most of the following problems practically at the end of the line HH.

Problem II It is required to find the outside and inside lap of the valve for an engine of 20″ stroke, to cut the steam off at $\frac{3}{4}$ stroke (15″) and to cushion the exhaust steam for 2″. The width of the ports is $\frac{7}{8}$″, the travel of the valve 4″, and no lead is to be given.

The points for cut-off and cushioning being given, the corresponding crank angles can readily be found, and they may be regarded as given, in the sketch Fig. 14. The lead, marked by a dart, should be made $= O$, in other words, the lap circle should rest on the line OA. If we draw the crank circle to $\frac{1}{8}$ scale it will coincide with the path of the eccentric.

It may be remarked here that Fig. 14 and most of the following valve diagrams are not made to full size, as they would

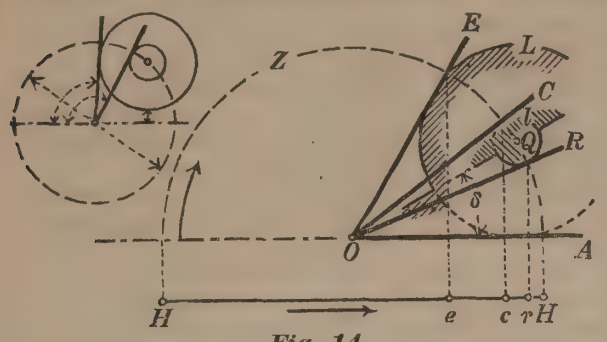


Fig. 14.

take up too much space. In practice, however, the eccentric path should always be drawn to full size to ensure a sufficient degree of accuracy.

The construction will be as follows. Sweep the circle Z with $2''$ radius. Mark on the line HH, representing the stroke of the piston, the points e and c, for cutting off and for cushioning, and obtain, through vertical projection-lines the corresponding crank-angles OE and OC. Both the lines OE and OA must be tangent to the lap circle, the centre of which will therefore be located on the circle Z by a line bisecting the angle EOA. The lap circles L and l can now be swept, from Q, tangent, respectively, to OE and OC, and the crank angle fo rrelease, OR, can subsequently be drawn. The radii of the lap circles are the required laps, which are found $1''$ and $\frac{1}{4}''$ respectively. The angular advance is $\delta = QOA$, the release, at r, takes place less then $1''$ before the end of the stroke, and the largest port-opening is $= 1''$, which is $\frac{1}{8}''$ above the width of the port.

(To be continued.)

The Second Series of Experiments showing the uses of the electric candle took place at the West India Docks, London, June 15 ; every thing worked satisfactorily. The *Chemical News* thinks that MM. Jablochkoff and Denayrouze may be congratulated on the success which attended the trial.

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

Progress of the St. Gothard Tunnel.—During the week before last, the progress of the St. Gothard tunnel was 32.5 meters on the Goeschenen side and 22.2 meters on the Airolo side, altogether 54.7 meters.—*Moniteur Ind. Belge.* v, iv, 324.

Down the Andes by Hand-Car.—At Anchi, 12,000 feet above the Pacific, the hand-car is loaded with its freight of six adventurous sight-seers, closely braced together. It is of ordinary construction and appearance, and does not offer any temptations to a pleasure excursion down the precipitous gorges of the Rimac, except that it affords an unobstructed view of the shifting grandeur and terrors of the route. As we descend in our rough vehicle at the rate of 60 miles an hour ; flying across aerial viaducts, or dashing through sepulchral tunnels ; threatened now to be crushed between converging mountain-walls, or precipitated from pendulous terraces,—the foaming Rimac emulating the maddening speed ; now glancing back to take a last look at the glistening pinnacles of the receding Andes ; or straining eagerly forward to catch the first glimpse of the royal city of the plain and the shining ocean,—the magnificence of the scenery and the magnitude of Mr. Meigg's achievement break upon us with fresh force, and not for any peril of the way would we forego the exhilaration and novelty of the trip. Far otherwise was it with one of the party, a stately commodore. He, who would face unflinchingly a whole broadside of murderous missiles, sprang from the car after ten miles over the wildest part of the route, declaring that nothing would tempt him to repeat such a foolhardy experiment. For the rest of us, the excitement and exhilaration of this mode of travel became so attractive, that we often went up to Anchi for the sole purpose of making the down trip.—"*A Railroad in the Clouds," in the "Midsummer Holiday Scribner."*

The Eads Jetties at South Pass.—A correspondent writes to the New Orleans *Times*, under date of Port Eads, July 5, 1877, as follows ; —"The fact of the passing of the steamship New Orleans this afternoon through the jetties on the ebb tide—it having fallen one foot three inches when she reached the bar of South Pass at three P. M.—is evidence at least of its affording the best outlet to-day. Her draught was eighteen feet four inches, to which add one and a quarter feet for the fall of tide, clearly demonstrates that there is a clear and unobstructed channel through the jetties of at least nineteen feet, seven inches on the present neap of low tides. She was taken through—as are all the Cromwell and Morgan steamers—by that careful and skillful pilot, Captain Francis, who has piloted all the steamboats of these lines for the past four months through the Jetty Channel, and as they pass at all times in the night or day, and without regard to state of tide, and never are delayed or detained, should satisfy all persons that the Jetty Channel, in the South Pass, is a safe one. When ships are piloted through by pilots who pay attention to the fluctuations of the channel—which are constantly occurring, and will continue to do so as long as the scouring-out process continues—there is no danger nor delay."

The Tunnel of St. Gothard.—The following we extract from the *Giornale du Lavori Publici* of June 20. "We have received the official report of the Lucerne conference on the St. Gothard tunnel. We publish the essential points of the report signed by the representatives of the interested states on the twelfth of this month, still awaiting the ratification of their respective governments.

"Among the network of railroad lines to St. Gothard not yet open to travel, the Immensee-Goeschenen, the Airolo-Biasca, and the Canazzo-Pino will be the first completed before the contracted time for the opening of the tunnel ; September 1st, 1881.

"The construction of the Immensee-Lucerne, the Zug-Arth and the Guibiasco-Lugano will be completed at the same time with the Immensee-Pino. In the mean time the company will hasten the construction of one or the other of these lines, submitting to the federal counsel a special financial justification demonstrating that the necessary resources for the construction of the Immensee-Pino shall not be entered upon.

"The fixed subsidy of 85,000,000 francs, according to Art. 17 of the Convention of Oct. 15, 1869, has been augmented by 28,000,000 fr., of which Switzerland will furnish 8,000,000 fr., Germany 10,000,000 fr., and Italy 10,000,000 fr.

"By the obligations imposed in the treaty of 1869, Switzerland is engaged in examining the plans and designs of construction and also the estimates relative to them. She will demand of the company a justification of expenses at least once every three months. The representatives of the three states engage themselves to support the final protocol to their respective governments. These states will make their decision known to the federal council before July 31, and in case the resolutions taken should be adopted, they will be taken as supplementary to the convention of October 15, 1869, and submitted for ratification to the chambers of the three powers.

"In case difficulties should be raised by any one of the contracting states, the federal council shall convoke a new conference. The Swiss delegates shall then present other propositions to the consideration of the federal council.—*Moniteur Industriel Belge*, v, iv, 303.

A Patent Electric System has lately been introduced on the trains of the Philadelphia, Wilmington and Baltimore Railroad. This system supersedes the present bell and cord arrangement to communicate with engineer, and also gives a continuous automatic alarm on the locomotive whenever any portion of the train becomes accidentally detached. The arrangement is also applied to freight trains.—*R. R. Gaz.* ix.

New Railway Signal.—The Pennsylvania Railroad Company has recently introduced on freight trains a new signal. It consists of a flashing light that indicates the speed and distance of a train, and shows whether it is at rest or in motion. This light is of two colors, one of them red and the other white, placed on the caboose, so that they may be seen in both directions on the line. A simple device for hiding the light at intervals is affixed to each lamp so that it may be made to alternately appear and disappear, and by suitable gearing this is connected with one of the axles of the car. While the car is at rest the lights are steadily visible ; when the train moves the lights flash once for each revolution of the wheels, and thus its movement and actual speed can be easily estimated as far as the lights can be seen.—*National Car Builder*, viii, 121.

A Projected Railway in Germany.—A project for constructing a new line of railway, which will be of great importance in the event of future military operations on the western frontier of the empire, has been recently laid before the German federal council. The proposed railway is to join Metz and Saarlouis by a route some twenty-five kilometres shorter than the already existing line. Moreover, by thus directly joining the Saar railway with the Alsace-Lorraine system the new railway will give, by means of the Saar line and a line already in course of construction along the valley of the Fishbach, a second railway communication between Mayence and the Rhine fortresses generally and Metz, entirely independent of the Courcelles-Forbach, Saarbruck-Neukirchen line.—*Nat. Car Builder*, viii, 121.

The South Pass Jetties.—(Report of Capt. M. R. Brown, U. S. Engs., on the progress of the work).

The Secretary of War has recently received from Capt. M. R. Brown, of the United States Engineers, stationed at the South Pass of the Mississippi, his report on the progress of the work on Capt. Eads's Jetties. Capt. Brown says that the expenditures upon this work during the last four or five months have been much greater than during any other equal period since it was begun. The result is that there is now an uninterrupted channel entirely through the pass to the sea 20 6-10 feet deep on an average at flood tide ; that with the exception one small mud lump, the twenty-two feet channel is 200 feet wide all the way through to within about 1,200 feet of the sea. From this point the twenty-two feet channel is narrower to within 145 feet of the sea. The lump mentioned. and the last 145 feet, are the only obstruction to prevent a vessel drawing twenty-two feet of water from passing through from the river to the gulf.

The officer in charge of this work is required by law to report to the Secretary of War when in his judgment the several payments for work become due ; and Capt. Brown expresses the opinion that Capt. Eads will very soon be entitled to his next installment of $500,000. A very lttle dredging would make him entitled to it now.

Capt. Brown reports that he has made a careful survey of the gulf bottom and front of the jetties for a distance of a mile seaward, and covering an area of over one square mile, and that he has also made a careful comparison of the depth ascertained with those shown by survey. He finds a slight average deepening of the contour lines on the outer slope. The bars down to fifty feet depth have receded, while little change occurred in the contour curves at a greater depth. Capt. Brown also refers to a remarkable deepening of the channel between the dykes at the head of the pass, and reports twenty-four feet of water through the shoal there. Below Grand Bayou, which is in the middle of the pass, there has been an enlargement of channel, and above Grand Bayou a fill of deposit. The latter is due to the fact that 250,000 cubic yards of material have been washed out from the shoal at the head of the pass. The total amount of material removed from the passes by the current since last March is 1,500,000 cubic yards. At the same time that the river was removing this million and a half of cubic yards of earth from the jetty channel, it was also transporting more than 14,000,000 cubic yards of sediment to the sea. Of the character of the construction Capt. Brown speaks very favorably. A large amount of stone has been used since the last report, and this of much better quality than previously employed in the Yazoo river. Eight hundred and fifty thousand cubic feet of mattress work has been put in place in the last four months on the jetties, and about as much more on the works at the head of the pass. The jetties are now in very good condition, no further sinking of the ends having taken place since March last. They will now withstand severe storms.

The River and Harbor bill of 1876 contained a proviso that when there shall be an open channel with eighteen feet of water at mean tide to and from the sea through the jetties, and to and from the port of New Orleans, no part of the $100,000 appropriated for dredging shall be any longer available. It is believed that the Secretary of War will immediately call upon Capt. Brown for a certificate showing the depth of water through the passes, and order the work at the Southwest Pass to be suspended. Capt. Eads has been in Washington to-day for the purpose of inducing the Secretary of War to issue an order regulating the use of the Southwest Pass, so as to prevent the destruction of his boats and barges employed in the work of construction, by the rapid passage of steamers. Several accidents of this kind have already oc-

curred. Capt. Eads desires to patent some improvements made in the construction of his dredge-boat which has just been built at Pittsburg.

Reclamation of the Zuyder Zee.—Active preparations are going on for the commencement of the long projected work of draining the Zuyder Zee. A dam nearly twenty-five miles long is to be carried across the gulf, and upon this pumping machines of 10,000 horse-power are to be placed, capable of discharging 6,500,000 cubic metres of water daily from the enclosed sea. It is estimated that the work will occupy sixteen years, and that it will cost 335,000,000 francs. The scheme if completed will form one of the greatest engineering feats of the world. It will change fishermen to farmers, and redeem the long lost acres from the floods, while the cities that have for centuries been buried may come to light also.—*Engineering News*, iv, 212.

The Algerian Interior Sea.—In a double communication, M. d'Abbadie and M. de Lesseps advocated that there was little foundation in the objections made to the project of M. Roudaire by M. Naudin and M. Cosson.—*La Nature*, v, 145.

MINING, METALLURGY AND MINERALOGY.

Crampton's Puddling Furnace —The furnace erected at Gratz has given very satisfactory results. The idea of puddling with powdered fuel is not, by any means, a modern idea, Director Sprung of Leoben having known of the process as early as 1849. At that time he heated his spherical combustion chamber by means of a blast and charcoal dust. —*Berg. u. Huetten. Zeit.* xxix, 251.

Roumanian Amber.—According to H. Biziste of Bucharest, Roumanian amber differs totally from the German amber found on the shores of the Baltic Sea. Both are the fossil resins of antediluvian trees and agree in chemical composition, but differ in color. German amber is found only of light colors—yellow, white, and pink—while Roumanian amber is red, pink, brown, blue, green, and black. These colors are frequently found mixed in a single piece, and we also have lumps with silver-colored veins and gold specks. On account of this variety of colors, the Roumanian amber is highly esteemed, and the darker and more beautiful pieces are more costly than yellow amber, especially as they are far more rare.—*American Builder*, xiii, 188.

Whitwell's Hot-Blast Stoves.—The following furnaces in the United States, it is stated in a circular by Thomas Whitwell, have Whitwell's hot-blast stoves in operation: Rising Fawn, Dade County, Georgia; Etna, Ironton, Ohio; Cedar Point, Port Henry, N. Y.; Dunbar, Fayette County, Pa.; Princess, Buena Vista, Kentucky. The following furnaces are now being supplied with them: Crane, Catasauqua, Pa.; Southern States, South Pittsburgh, Tenn.; Moss & Marshall, Perry County, Ohio; Ashland, Boyd County, Kentucky; Norton, Boyd County, Kentucky; H. Campbell & Sons, Ironton, Ohio; Rhodes & Bradley, Perry County, Ohio; Milton, Jackson County, Ohio; Ogden, Hocking County, Ohio; Winona, Perry County, Ohio; Bessie Furnace, Ohio.—*Bulletin*, xi, 209.

The Tin Deposits of Banca were first worked from 1700 to 1720, but with small production. After that period numerous Chinese miners flocked thither, and by degrees extended the workings over the entire island. The most prosperous season was between 1770 and 1775, when about 3800 tons of metal were annually produced. Subsequently the production fell off very much, but has lately increased again. The entire product, however, of both the Malay Peninsula and the islands was not, in 1848, as large as the amount formerly derived from Banca alone. The process of mining is very simple, and the ore is found intermixed with yellowish sand, or in fragments of felspar and quartz, resulting from the decomposition of granite. The smelting is effected on the spot, with charcoal, in rude furnaces; the bellows employed being the hollow trunk of a tree, in which a piston is worked backward and forward; 80 to 90 picules being produced in a night's work, and, from the good quality of the ore, no refining is needed. The Australian tin deposits, discovered to be workable only in 1870, have increased so largely in productiveness that, up to the end of 1874, ore worth 4,300,000 dollars had been obtained in New South Wales (the exports from that colony, in 1874, amounting to 2,400,000 dollars,) while the area of tin-bearing land, in the same colony, was estimated at 6250 square miles, and in Queensland at 22,000 acres. The tin ore of New South Wales is partly from veins in granite, but mainly from washings. Some of the specimens of stream tin at the Centennial Exposition were almost unsurpassed in size and beauty. Queensland is stated to have produced, for some years after 1872, about 5000 tons annually. —*The Engineer*, xliv, 59.

A Coal Miner, who strikes to some purpose, has been put to work—by hydraulic pressure. The said miner is an expanding plug which wedges off the coal.

—New Caledonia has exported about 2000 tons of nickel since the discovery of nickel ore at Mont d'Or in 1874. The ore is found in various localities, but the hopes of an extensive product raised by its wide distribution, has not been realized.

—Specimens of silver ore recently taken from the Cerro de Pasco silver mines in Peru show that the submerged portion of the mountain is very rich, and a rough estimate shows that a body of ore will be exposed by the new tunnel which Henry Meiggs is to build, worth from $300,000,000 to 500,000,000. These mines have lain under water for fifty years, and are scarcely known to the present generation, though they had been worked for two hundred and fifty years when the mines had to stop on account of water. Peru has now discovered that a tunnel can be built which will drain the mountain completely, by draining off the lake from which the water in the mine comes, and she is so much in earnest about it that the first loads of the now submerged ore are expected to reach Lima in four months. It is predicted that within ten years more silver will be taken out than from the silver mines in Nevada.

—A process has been patented by Alfred Monnier for the purpose of reducing refractory ores by roasting and lixiviation.

—The Roane Iron Company, Chattanooga, Tenn., is opening mines of gray specular ore at Cartersville, Ga., and at other points, which ore is suitable for the manufacture of steel.

—A very extensive mine of black lead has been discovered in Floyd county, Ga., and will soon be opened.

—Iron ore, said to be of good quality, has been discovered on the farm of Mr. A. J. Bigley, at Alpsville, on the line of the Pittsburgh division of the B & O. railroad. Alpsville is above McKeesport.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Pressed Bricks from Blast Furnace Slag.—We are informed by the *Würt. Gwbtt.* that pressed bricks have been made from blast furnace slag by Eng. F. Dopfer. To the powdered slag 42 per cent. silicic acid, 37 per cent. gypsum, 10 per cent. clay, 5 per cent. oxide of iron, 3 per cent. magnesium, 1½ per cent. sulphur, and various other materials mixed with lime are added. The mixture is given the common brick form in a steam press and after drying in the air for three months are ready for use. The daily production of the presses are about 8,000 bricks. The cost at Wasseralfingen is 32 marks per hundred (probably 1000. Ed.)—*Industrie Zeit.*, xxix, 288.

Waterproof Leather.—Melt 1 litre of boiled linseed oil, 125 grammes of suet, 46 grammes wax, and 32 grammes resin together over a slow fire, and apply it to the leather with a brush while warm. This composition keeps the leather very soft. The English fishermen have long been using it. They can remain in the water for hours ere it penetrates through the leather. The only thing new in the compound is the addition of wax and resin to the fatty matter.—*Bay. Ind. und Gew. Blatt.* v, xix, 212.

To Oxidize Silver.—Dissolve 100 grammes sulphuret of ammonia in 1 litre hot water. Dip the article into the solution for a few moments, rinse in cold water, and scratch with a wire brush.—*Papier-Zeitung*, v, ii, 472.

A Brilliant Signal Light. By mixing equal quantities of powdered magnesium and powdered chlorate of potassa, an intensely luminous compound can be produced. When touched by a live coal it instantaneously produces a most intense white light that will answer admirably for signal lights.—(*Jahresb. d. phys. V. Frankfurt*), *Ind. und Gew. Blatt.*, v, xix, 212.

Preservation of Wood.—*The Ind. Blätt.* in speaking of the well-known methods of preserving posts and wood which are partly imbedded in the earth, by charring and coating with tar, says these methods are only effective when both are applied. Should the poles only be charred without the subsequent treatment with tar, the charcoal formation on the surface would only act as an absorber of the moisture, and if anything, only hasten the decay. By applying a coating of tar without previously charring, the tar would only form a casing about the wood, nor would it penetrate to the depth which the absorbing properties of the charcoaled surface would insure.

Wood that is exposed to the action of water or let into the ground should first be charred, and then before it has entirely cooled be treated with tar till the wood is thoroughly impregnated. The acetic acid and oils contained in the tar are evaporated by the heat and only the resin left behind, which penetrates the pores of the wood and forms an air-tight and waterproof envelope.

It is important to impregnate the poles a little above the line of exposure, for here it is that the action of decay affects the wood first and where the break always occurs when removed from the earth or strained in testing.—*Maschinen Constructeur*, xxiv, 279.

Gerlach's Ammonia Soda Process.—The ammonia soda process, in its application to the disposal of gas liquors, as patented by Dr. Gerlach, is distinguished from the ordinary ammonia process in several points. He effects the best possible utilization of gas liquor, and brings continually fresh quantities of gas liquor into play. The ammonia soda process, on the other hand, aims merely at the production of soda, and reconverts the sal-ammoniac employed again and again into caustic ammonia. The sal ammoniac obtained by decomposing gas liquor with common salt is in the Gerlach procedure recovered by crystallization, and not reintroduced into the circuit of the operation as caustic ammonia. Hence there is no loss of ammonia by volatilization. No lime is employed, save the trifling quantity used in the distillation of the gas liquor for the decomposition of non-volatile, ammoniacal compounds. No common salt is wasted, but it returns continually into the circuit of the operation. For every equivalent of chloride of sodium employed a full equivalent of soda is obtained as a by-product, which has not hitherto been found practicable in the ammonia soda process. The cost of the recovery of the ammonia is saved, as the solution of chloride of ammonium yields crystals of sal ammoniac on slight evaporation. The production of sal ammoniac and that of soda is continuous, while fresh quantities of gas liquor are constantly brought into use. The defects pointed out by practical men in the common ammonia soda process are the great quantities of solutions to be dealt with, the enormous consumption of coal depending on the continual recovery of the ammonia, and the unavoidable loss of the latter reagent.

The weak side of Dr. Gerlach's process appears to be that the alkali manufacture could only be carried on where a large and constant supply of gas liquor is available, and that the yield of soda would be necessarily limited by the quantity of a by-product.—*Dingler's Polytechnic Journal.*

The Supposed Mercurial Poisoning by Colored Vulcanite.—An impression has long prevailed that it was possible for the salts of mercury, used to color red vulcanite, to exert a poisonous influence where red rubber plates were worn in the mouth; and the attention of the Odontological Society having been strongly drawn to the subject by Dr. Bathurst Woodman's papers (see *Trans. Odont. Soc.*, 1875), relating cases of supposed mercurial poisoning from this cause, a committee was appointed to collect evidence and report upon the subject. Their inquiries have however utterfailed to establish the existence of a single case of unquestionable, or even probable, mercurial poisoning due to the use of red vulcanite plates. The committee requested Professor Attfield to make "an investigation of the influence, if any, of saliva and the other fluids of the human body on the pink and red varieties of vulcanite used by dentists in making artificial teeth-plates, gums, and palates." These tinted varieties of vulcanite are made by heating pink or red "dental rubber," under pressure, to a temperature of 310° to 315° F. (154° to 157° C.), the "dental rubber" being prepared by incorporating sulphur and vermillion with pure india-rubber. The following are the results of Dr. Attfield's investigation— 1. So far as any action on man is concerned vermillion is a harmless substance. 2. So far as any effect or influence of the vermillion is concerned, the mixture of vermillion, sulphur, and india-rubber, commonly termed "dental rubber," is also a perfectly innocuous substance. 3. Pink or red dental vulcanite, even when placed under the severest conditions of experiment, does not yield any trace of mercury to saliva, or, indeed, to other far more powerful solvents. 4. The metallic pins and braces in dental vulcanite do not displace mercury, or induce the formation of any compound of mercury soluble in saliva or in more powerful solvents. Dr. Attfield is therefore of opinion that vermillion vulcanite teeth-plates are practically unaffected by saliva, or by any substance which ever gains access to the mouth; and, in short, that the pink and red vulcanite artificial gums and palates now so generally worn are absolutely harmless.—*Chem. News*, xxxv, 265.

Extraordinary Case of Persistence of Image in the Human Eye.—Dr. P. Gorini has given an incident which is interesting as a case of persistent image on the retina. Having fallen asleep one night while reading a book, he wakened, when on the wall opposite, he observed it covered with the text of the book he had been reading; the annotatians in smaller type he also distinguished. The whole appearance was vague and indistinct, but there was no doubt it was that of the page he had been reading. The apparition lasted about twenty minutes, and in this space of time was reproduced several times upon opening his eyes after closing them.—*Druggists' Circular.*

A New Method for the Titration of Alkalies and Acids.—Phenolphtalein, which is produced by heating carbonic acid with anhydrous phtalic acid and sulphuric acid is colorless in a diluted state, but immediately becomes intensely purple in presence of the slightest excess of alkali.—*Fresen. Ztschr.*, 1877, 332.

Process to Render Plaster Casts Impervious to Water.—Several prize essays upon this subject have recently been written. Dr. W. Reissig of Munich, changes the surface by means of silicate of potassa into silicate of lime or by means of baryta water into sulphate of baryta. G. Leuchs, of Munich, advocates baryta and lime water; and Dr. F. Filsinger, of Dresden, a treatment first with baryta water and then, after drying, with boracic acid.—*Verhandl. d. Ver. z. Beförd. d. Gewerbfleisses*, 1877, vi, 375.

Sewerage.—Dr. C. F. Folsom, Secretary of the Massachusetts State Board of Health, makes use of the analyses of the water of the river Seine in its course through Paris, which throws light on the subject of pollution of streams: "Pure water holds about 10 per cent. of oxygen in solution. When impure matters are added, this oxygen may all, or nearly all, disappear in the destructive oxidation of the impurity. The oxidation being complete, the absorption of oxygen from the air gradually raises the proportion to the normal standard. It was found that the Seine above Paris contains 9 per cent. of oxygen; in the upper part of the city 8 per cent.; below the city, but above the outlet of the main sewer, 6 per cent. From this point the proportion falls off rapidly, until below all the sewers the oxygen is reduced to 1 per cent. Thence it increases until seventeen miles below the sewers it is 6 per cent., twenty-seven miles further, 9.5 per cent., and thirty-five miles further 10.5 per cent.—*Nation*, 631.

MISCELLANEOUS.

One of the Largest Gold Balances in the World was recently made for the U. S. mint by Henry Troemner, of Philadelphia. The beam measures 5 feet 6 inches in length, is mounted on agate bearings, with a capacity of 10,000 troy ounces (about 600 lb.) in each pan, and is sensible to one grain when loaded. Over twenty million dollars of gold pass over this balance yearly. The workmanship, of course, is the very finest.—*American Manufacturer.*

Destructive Insects, and Paris Green.—The objections made to the use of Paris green used for the purpose of destroying the potato-bug has been met satisfactorily through the investigations of the agricultural editor of the *Tribune*. He says that it has been proved that there is no trace of arsenic in the potato-tuber, though there should be more applied to the tops than is necessary to protect them from the ravages of the beetle or its grub; and that other crops may be raised on the same soil without any trace of arsenic in them. He concludes thus: "Therefore, it can be unhesitatingly affirmed that no harm will result from the proper use of this substance for the protection of the potato even so far as regards the effects that may be produced on the crop itself, or on other crops following it." Particular care must be exercised in inhaling such a poisonous substance. When the powder is dusted it should not be allowed to come into contact with any sore or abrasion of the skin. Children should not be allowed to play in a field recently dusted. All these dangers can be avoided by the method of sprinkling plants with water holding the powder in suspension, which is perhaps the best mode of applying the poison—a teaspoonful of it in every two or three gallons of water is said to be sufficient. As these dangers may thus easily be avoided, it is folly that an important crop need be ruined because the only effective protection against its enemy is found in the use of this poisonous substance. The preventive is more effectual against the grub than against the beetle.

A New Fire Escape.—Mr. John W. Wilkins, an English gentleman who has travelled much and who is a good observer, was in St. Louis during the great hotel fire there, and like many others set himself the task of devising a simple mode of escape. The result was tested recently at the Howard Hotel, Philadelphia. A rope made fast in the room, has upon it a block of wood with two holes through which the rope passes. The lower end is fashioned to fit the hand, and an iron hook is fastened to it. From the hook a web sling is suspended, in which the person to lower himself sits. To this, also, satchels, or for that matter a sheet holding children, may be hung. The rope passing through the lower hole first and then through the upper hole, has what sailors would call a single turn. Left to itself, a very slight weight suspended to the wooden block would run freely down the line, but the pressure of a few ounces on the rope as it passes through the chock controls the speed. To suit hands unused to ropes a leather guard, fastened to the handle, laps over the line, and the descending person seated in the sling holds the rope on the shaped end of the block under the leather guard. Mr. Wilkins' idea is that every hotel should provide ropes rove through one of these sliding blocks, and that guests should be provided with other blocks of the same construction, except that they are made in two parts and working on a pivot, can be attached to the rope from any window from which it can be reached. They take up the same room in a satchel as a hairbrush. Mr. Wilkins recently just before dusk let himself down three times from an upper story of the Howard House, and demonstrated the practicability of his invention.—*Phila. North American.*

A Culinary Suggestion.—Prof. Vogel proposes to destroy or remove the extra acidity of fruit by means of liquor ammoniæ—a method which he declares is as useful for preserves intended to be kept, as for compôtes for immediate use. The process is stated to "much improve" the taste of conserves, and to permit of a considerable saving in sugar.

Matches.—The extent to which the manufacture of matches is carried can be but faintly indicated by means of figures. The demand for them in Great Britain is, on an average, eight daily for each individual; in Belgium, nine per head; and, for Europe and North America, the entire average is six to every inhabitant. To meet this demand matches are produced by the million, and the wax taper before division in small pieces, is measured by the mile. It is stated that one pound of phosphorus is sufficient for 1,000,000 matches, through the proportion varies greatly. In France there are consumed for his purpose 70,000 pounds of phosphorus every year. The largest makers are in Austria, two of whom use twenty tons of phosphorus per annum, and produce nearly 45,000,000,000 matches. One firm in New York uses annually 700,000 feet of choice white pine timber, 100,000 pounds of sulphur, and 150 tons of straw-board for their boxes. Large quantities are exported from the United States to the East and West Indies, China, South America, and other countries. At the census taken here in 1870 there were found to be 75 establishments engaged in the business, and the value of the product for that year was $3,540,000.—*Popular Science Monthly.*

Wood Staining.—The following recipes for staining wood different colors are given in *Dingler's Polytechnisches Journal*, per the *English Mechanic*. In most cases the staining of wood may be effected so as to produce very bright colors without any previous preparation, as, generally speaking, the mordants employed have a bleaching action on the wood. But sometimes, in consequence of the quality of the wood under treatment, it must be freed from its natural colors by a preliminary bleaching process. To this end it is saturated as completely as possible with a clear solution of 17¼oz. chloride of lime and 2oz. soda crystals, in 10½ pints of water. In this liquid the wood is steeped for half an hour, if it does not appear to injure its texture. After this bleaching it is immersed in a solution of sulphurous acid to remove all traces of chlorine, and then washed in pure water. The sulphurous acid which may cling to the wood in spite of washing does not appear to injure it, or alter the colors which are applied.

Red.—The wood is plunged first in a solution of 1oz. of curd soap in 35 fluid oz. of water, or else is rubbed with the solution; then magenta is applied in a state of sufficient dilution to bring out the tone required. All the aniline colors behave very well on wood,

Scarlet.—Besides the aniline colors, which are, however, much affected by sunlight, cochineal gives a very good scarlet red upon wood. Boil 2oz. of cochineal, previously reduced to a fine powder, in 35oz. of water for three hours, and apply it to the wood. When dry, give a coating of dilute chloride of tin, to which is added a little tartaric acid, 1oz. of chloride of tin, and ½oz. of tartaric acid in 35 fluid oz. of water. If instead of water the cochineal is boiled in a decoction of bark (2oz. bark to 35oz. of water), and the chloride of tin is used as above, an intense scarlet, and all shades of orange, may be produced according to the proportions.

Violet.—The wood is treated in a bath made up with 4¼oz. olive oil, the same weight of soda ash, and 2½ pints of boiling water, and it is then dyed with magenta, to which a corresponding quality of tin crystals have been added.

Blue.—Prepare as for violet and dye with aniline blue.

Green.—Mordant the wood with red liquor at 1° B. This is prepared by dissolving separately in water one part sugar of lead and four parts of alum free from iron; mix the solutions, and then add one thirty-second of a part of soda crystals, and let settle over night. The clear liquor is decanted off from the sediment of sulphate of lead, and is then diluted with water till it marks 1° B. The wood when mordanted is dyed green with berry liquor and extract of indigo, the relative proportions of which determine the tone of the green. The wood, mordanted as above directed, can also be dyed a *fine blue* with extract of indigo.

Yellow.—Mordant with red liquor, and dye with bark liquor, and with turmeric.

Brown.—Various tones may be pruduced by mordanting with chromate of potash, and applying a decoction of fustic, of logwood, or of peachwood.

Grey.—Greys may be produced by boiling 17 oz. orchil paste for half an hour in 7 pints of water. The wood is first treated with this solution, and then, before it is dry, steeped in a beck of nitrate of iron at 1° B. An excess of iron gives a yellowish tone; otherwise a blue-grey is produced, which may be completely converted into blue by means of a little potash.

Black.—Boil 8¾ oz. of logwood in 70 oz. of water, add 1 oz. blue stone, and steep the wood for twenty-four hours. Take out, expose to the air for a long time, and then steep for twelve hours in a beck of nitrate of iron at 4° B. If the black is not fine, steep again in logwood liquor.

Pyritous Residues as a Road Making Material.—It is a well known and popular custom of utilizing pyritous residues for making roads, since these have the effect of keeping the road dry for a long period. Some of these residues, however, contain zinc blende, which occasions the formation of the sulphate of zinc under the influence of rain water, and by the filtration of this into adjacent wells many cases of poisoning can be anticipated. Sarrazin (in *Dingler's Journal*) has examined the water of a well in the neighborhood of Nieuburg (the water of which was found to coagulate some milk that it was to adulterate), and found it to contain iron and sulphate of zinc. On investigation the cause was found to be some pyrites that had been used for repairing an adjacent road. A second well was likewise found to contain some sulphate, though less iron than the first. In some localities it was insisted upon that the vegetation had been blighted by the water which drained from the road into the fields.—*D. A. Polytech. Journal*, v, 330.

Preservation of Wood.—During the excavation of a canal in Berlin the workmen struck upon twelve perfectly preserved coffins, which laid apparantly in four graves, each containing three superimposed coffins. The site of the discovery corresponds with the cemetry that existed even as late as 1620 in connection with the poorhouse and pestilent hospital. The corpses must in consequence have been in the earth for at least 260 years. Notwithstanding this long period, the coffins, as well as their contained bones, are in a perfect state of preservation; articles of clothing have even been found still clinging to some of the bones. Prof Virchow found upon investigation that the coffins were coated on both sides with a thick layer of tar, the wood itself appearing to be young oak of 3 cm. thickness. A silicious crust was likewise found on the inner side of the coffins. The wood is so hard that axes and saws were broken in the attempt to cut it. The wood is held together by long wrought iron nails which appear very different from those used at present. They are 8 cm. long, 4 mm. wide, and 2 mm. thick. They all have a groove running along their entire length, apparantly to increase their surface contact. The nails are very much rusted, but are still sound in their interior.—*D. A. Polytech. Ztg.*, v, 318.

Extraordinary Longevity.—Dr. B. Ornstein, surgeon-in-chief of the Greek army, gives the following interesting item: A citizen of Smyrna died at the age of 132 years. Though he lived rather an intemperate life, he was at the last moment in full possession of his senses, as also of his teeth. He pursued the occupation of baker to the end of his days; was quite active, and could dance and sing when intoxicated. His longevity is remarkable in connection with the historical changes. The deceased, being born in 1743, has witnessed the reigns of 9 sultans; was born 9 years before the unfortunate Louis XVI, of France; older than Pope Gregory V, by 5 years; 26 years older than the great Napoleon, and 32 years old before the American Revolution commenced.—*Druggists' Circular.*

A Good Plastic Material.—Five parts of sifted whiting mixed with a solution of one part glue, together with a little Venice turpentine to obviate the brittleness, makes a good plastic material, which may be kneaded into figures of any desired shape. It should be kept warm while being worked. It becomes as hard as stone when dry.—*American Builder*, xiii, 188.

A Ship Float has lately been put in use in England, says *Engineering*, by means of air-bags to support the ship within the dock or float which are distended by air-compressors worked by engines. Any part of the ship's bottom may be reached by removing one or more bags.

—A New Pneumatic Railway is about to be put in operation in London.——The Pittsburg Exposition will have on exhibition the engine and two passenger coaches built by John Stephenson in 1833.——A commercial agency is about to be established in Philadelphia, for the South Centra lAmerican products.——The worthless locomotives at Pittsburg number 50; the others were sent to Altoona for repairs.——In the manufacture of Portland cement, an Englishman has patented an improvement, which gives a better quality of material.——Bickeroux's Gas Furnaces are substituted for the ordinary single puddling furnaces in the Ougreé Iron Co., a saving of coal and labor.

The Camden and Atlantic R. R. Co. has been collecting from time to time the products of the section of the country through which it passes for its Permanent Exhibition exhibit.

The Manufacture of Potato Starch comprises 225 factories, nearly all of which are in the Canadian frontier States, From 1½ to 3 millions bushels of potatoes are annually consumed.

—Twelve thousand sewing machine needles are made daily at the Domestic Needle Works, Middleboro, Mass. Fifteen thousand per month are sent to Australia.

—Foreign papers believe that Europe can take 2,000,000 head of cattle from the United States every year, the limit of cattle-rearing having been reached in many parts of Europe.

—Sheffield advices of the London *Times* note that "there has been a steady diminution of our shipments of steel, hardware and cutlery during the past six months, although there has been a slight improvement in our exports of steam engines, steel and iron wire, wrought iron bars, hoops and plate."

—The Philadelphia Bridge Works, Cofrode & Saylor, have contracts for twelve bridges, and a large amount of other work, such as station buildings, etc. They are building the Penrose ferry bridge, a draw span of 412 feet, over the Schuylkill river. They are pushing all work forward as rapidly as possible.

—A number of coal mines are to be opened in Cameron county, Pa.

—The King Iron Bridge Company, Cleveland, has contracted since January 1st to build over 100 bridges.

EDITORIAL CORRESPONDENCE.

EDITORS POLYTECHNIC REVIEW:—

Gentlemen: I am this day in receipt of the REVIEW of August 4th. On page 57 I find copied from *Van Nostrand's Magazine* a description of the new military "range finder" credited to a German General Berden. This is purely an American invention, and here is something of its history. When a boy low down in my teens, I was passionately fond of rifle shooting, and always improved every possible opportunity for that, to me, fascinating practice. Thirty two years ago I commenced practicing with excellent success at long ranges of 500 yards and upwards. About that time the idea of a "range finder" occurred to me, and I constructed a rude instrument on the plan described in the article copied by you. My sights were like those of an old fashioned surveyor's compass. My instrument was for mounting on a tripod, but was too rude to be accurate.

During the war of the rebellion I raised, and for a time commanded, a company of the U. S. Sharp Shooters for the corps organized by the well-known Col. Berdan. While the regiment was encamped at Stoneman's Switch, near Fredricksburg, I was one day in the Colonel's tent, and in course of conversation concerning long range practice, etc., the subject turned upon the methods of finding range. I referred to my crude attempt to construct an instrument. The Colonel said the same idea had occurred to him, and that it was feasible by making use of such perfected telescope sights as we had upon our rifles. The Colonel (now General) invented an important improvement in breech loading fire-arms. Among other governments adopting his improvements was Russia, and the General is now and has been a long time in Russia, superintending the improvement in Russian arms. Some two months ago I saw a translation from a German journal giving an account of his perfecting the range finder. The article was identical with that which you publish, except the transformation of my old Colonel into a German General, which he is not.

Yours truly,

MILTON P. PEIRCE,

Formerly Captain U. S. Sharp Shooters.

"AQUADALE," Wenonah. N. J., Aug. 6, 1877.

BIBLIOGRAPHICAL NOTICES.

SAFETY VALVES. By Richard H. Buel, C. E. (Van Nostrand's "Science Series," No. 21.)

This little work, of 96 pp. 18mo, originally appeared in the *Railroad Gazette;* and we do not think that in it Mr. Buel has done either himself or the subject justice. In other words, it is neither a popular essay nor a thorough treatise, and could very well have been improved by writing it in popular form with the heavier portions run in as copious footnotes. The requirements of a good safety valve are nowhere summed up. The absurdity of laying down a general rule to fit any boiler, like a key that "fits any watch," is sufficiently demonstrated on page 50, although the author does not point it out very forcibly. There are given seven rules for calculating the area of valve required, and none of them agree, the area varying from 6.94 to 23.63 square inches for the same boiler, according to which rule is chosen. Two rules by one authority (Prof. Thurston) give results varying nearly 50 per cent.

Most valves are too small, and of those that are large enough, as well as of the small ones, nearly nine-tenths either stick, or do not keep tight, or open out too suddenly for safety, or have springs whose increasing tension under compression prevents a full opening. There is yet room for correct practice and a practical work on the subject of safety valves.

THE FATIGUE OF METALS UNDER REPEATED STRAINS. Translated by S. H. Shreve from the German of Prof. Ludwig Spangenburg. (Van Nostrand's "Science Series," No. 23.) 18mo, 20 pp., boards.

The valuable experiments of Prof. Wœhler as to the effects produced upon metals by oft-repeated impacts or strains were continued by Spangenburg, and have been before the public for years without exciting the attention demanded by the importance of the results obtained.

These experiments proved that repeated shocks or vibrations or changing loads, while individually nowhere near the straining limit of the material, would, by their too frequent repetition, produce rupture; that alternation of compression and tension "wore the life out" of metals proportionally more than steady tension or steady compression, being really the sum of the two strains. The limit of strain of iron in structure was shown to be far below that ordinarily assigned, being but little over 30,000 lbs. for the best material; and the dangerous character of those trusses in which there is *ambiguity* of strains was pointed out and proved. And yet engineers still lay immense stress upon ultimate strength, elasticity, elongation under strain, &c., without considering the true nature of the usage to which the materials are subjected in practice.

We hope very much that the opportunity afforded by the translations of Weyrauch's and of Spangenburg's works will awaken English-speaking engineers to a proper consideration of the strain-problem, and to a continuation of the experiments of Wœhler and of Spangenburg. Civil-Engineer Shreve is a competent person to make the translation.

SELECTED LIST OF U. S PATENTS.

JULY 17, 1877.

Patents granted July 17, 1877, 242. Reissues, 14. Designs, 7. Trade-marks, 8. Labels, 5.

193,072. MOULDS FOR CASTING RIBBED SURFACES. S. H. Bingham, Philadelphia, Pa. Casts ribbed stereotype plates for cylinder presses.

The casting-box or flask is provided with a movable top or cope and an arrangement of levers or arms whereby the same is raised a line vertical to the drag, to prevent injury to the ribs, and is then axially rotated.

193,085. STEAM-GENERATORS FOR WARMING BUILDINGS. B. Holly, Lockport, N. Y.

A train or series of boilers are connected together and to a feed-water supplying apparatus, and to a draft flue, by pipes and flues furnished with cocks or valves and dampers, whereby, at the will of the engineer, all the boilers can be used for generating high-pressure steam, or a portion of the train be used for generating high-pressure steam and the remainder for generating low-pressure steam, or for heating and supplying feed-water.

193,086. APPARATUS FOR SUPPLYING STEAM FOR HEATING LARGE DISTRICTS. B. Holly, Lockport, N. Y.

Boilers are centrally located, and the underground street-mains are adapted to obviate the injurious effects of expansion and contraction. There are also means provided for regulating and recording the supply of steam to each house, and supplying steam at high or low pressure, but these appliances are not capable of brief description.

193,094. COTTON-OPENER AND CLEANER. Richard Kitson, Lowell, Mass.

The cotton is delivered to and operated upon by a first beater, the rotation of which generates a current of air sufficient to carry the cotton into and through the trunk to a condenser box, where it is caught by fluted rolls and fed outward to the second beater, in a uniform quantity, to form an even lap.

193,097. PLATE-PRINTING PRESS. James Milligan, Brooklyn, N. Y.

The plate-beds are joined to an endless chain, and are carried around in horizontal ways on a right-angled frame, under adjustable inking devices and the impression-cylinder. They are stopped at each corner of the frame by pins on the chain striking an arm of a rock-shaft linked to the driving-clutch. One end of the blanket is attached to the cylinder and the other to a weighted cord. Adjustable projections on the beds move the cylinder before and after the plate comes in contact with the blanket.

193,106. MECHANISMS FOR OPERATING THE ROCK-SHAFTS OF YARN-SPOOLERS. William Bancroft, Hopedale, Mass.

The thread guide-rail is forced upward and downward by mechanism positive in its action; *i. e.*, a toothed sector is fastened directly to the rock shaft, and gears with a pinion on one side of the mangle-wheel. On the other side of the mangle-wheel is a pinion upon the end of a shaft which engages the row of pins on said wheel, and revolves it first in one and then in the other direction, thereby imparting a reciprocating rotary movement to the rock-shaft.

193,141. TWISTING-SPINDLES FOR MAKING CORDAGE. Charles E. Brownell, Moodus, Conn.

The lower plate, which supports the fliers and spindle, is arranged loosely upon said spindle, and capable of being revolved in the same direction as, or in the opposite direction to, that of the spindle, so as to impart a tight or loose twist to the strand, as may be desired. Springs are attached to the upper plate to stop the machine automatically when a strand breaks.

193,147. CANAL LOCOMOTIVES. Gabrielle de Nottbeck, New York.

A track is laid along the bed of the canal, and a locomotive is fitted to travel thereon, the boiler and machinery being supported upon high trucks above the water. The locomotive tows the boat by direct draft.

193,152. RIDING PLOW. J. L. Florence, Plano, Texas.

The axle is cranked rearward. The rear end of the frame is journaled upon the crank and vibrates vertically in the space between the ends of the axle, the free end of the frame projecting forward. Upon the frame the plow is mounted, and adjusts laterally. An angular lever raises the crank and plow, and another has two furrow-wheels journaled upon its extension. Hooked arms upon the plow bearing-plate engage the crank, and tilt downward the front end of the plow-beam when being raised.

193,157. SPRING HINGES. George Geer, Unionville, Conn.

A three-leafed hinge, double-acting, for swinging the door in either direction, is combined with a two-part toggle-frame and spiral spring. The middle leaf of the hinge has a short arm at each end, and the outer leaf is also provided at each end with an arm which stands at right angles to the body thereof, the arm carrying the jointle of the hinge. The construction adds strength, and alternately compresses and expands the spring as the arms pass the dead centre. A single-acting strong hinge may be constructed in like manner by providing the middle leaf with screw-holes and cutting off or omitting the parts which connect it with one of the outer leaves.

193,161. MACHINE FOR DAMPING, CUTTING AND FEEDING PAPER. Gustav L. Jaeger.

From the roll the paper passes, in contact with a hollow foraminous steam damping-roller, to feed-rollers, one of which is of rubber and is capable of circumferential expansion by clamp-nuts applied at each end thereof, whereby the feed is adjusted to a slight degree. The paper is cut in sheets by a rotary cutter having a curved guard-point, which bears against the stationary cutter, the separate sheets falling upon a vibrating chute, from which they are delivered to the gripper-cylinder, having in combination a rock-shaft carrying gauge-arms which are operated by a cam upon the cylinder. The feed is, in addition to the above-described adjustment of the rubber roll, varied by detachable gear of varying sizes.

193,171. STONE-QUARRYING MACHINE. J. B. McRae, Helena, Ark.

This machine is designed to work in soft stone, and to cut the stone directly into blocks of the required size for building purposes. The operative mechanism is mounted upon a car which is provided with a steam-engine or other motor whereby an adjustable vertical saw and an adjustable horizontal saw at the front of the car are operated, and back of the same is a third vertical adjustable saw at right angles to the front saws, to divide into blocks the long pieces of stone cut loose by the front saws. A lever which engages and disengages friction gear connecting by a train of wheels with the front axle is used to propel the car forward as the cutting progresses.

193,202. ADJUSTABLE GAUGES FOR SAW-MILLS. Franklin Wheeler, Berlin, N. H.

The gauge-roller is attached to the outer end of a sliding-bar longitudinally adjustable between guides formed upon a perforated bed and held in position by a latch-pin secured to a spring latch pivoted to a vertical handle on the upper outer end of the sliding-bar.

193,207. ART OF MAKING THREAD. A. A. Arnold, Newark, N. J.

The first doubling and twisting of the yarns into a strand is made in the direction in which the said yarns were spun. The improvements in those parts of the machine that manipulate the yarns previous to the reeling of the finished thread are based upon the mechanism covered by letters patent No. 7007, January 8, 1850. Said improvements relate to minor details of construction; also to the ruling mechanism, embracing a traverser and the operating mechanism, and a counting mechanism; also to the lubricating devices for the spindles, all as set forth in the claim.

193,228. MINE PUMP. E. Daggett. Salt Lake City, Utah.

Two stationary pump-barrels with suitable valves, and two reciprocating pipes which operate the valves, are united together and operate simultaneously, so that the several barrels and pipes co-operate as one pump, the water being forced from the lowest pump to the one next above, and so on until it can be freely discharged at the top of a shaft, or any lower point from which flowage may be desirable.

193,252. MACHINE FOR MILLING, POINTING, AND SHOULDERING KEYS. Henry G. Hotchkiss, New Haven, Conn.

The tools for pointing, milling the body, and shouldering the key are advanced to their work, in the order named, by means of a cam acting on pins on as many sides, the first passing through the hollow spindle and chuck, the two last pivoted centrally beneath the key on a common shaft. The milling jaws are connected to their slide by links, and open or close as their slide advances or recedes. One of them is rabbeted to receive the shouldering tool, which has a spring connection with its slide.

193,279. AUTOMATIC TRAIN-BRAKES. H. L. Perrine, Freehold, N. J.

One pipe, open to the reservoir, conducts air to the brake-valve under the diaphragm, and thence to the cylinders. A second pipe conducts air above the diaphragm. When air is let out of this pipe, the diaphragm is raised by the pressure on the under side, which opens the valve to the cylinder, allowing air to enter from the first-mentioned pipe and applying the brakes. To release the brakes, the pressure is restored above the diaphragm, which closes the induction valve and opens an exhaust. If the car couplings break, the short hose-couplings separate, let the air out from above the diaphragm, and apply the brakes. The last car is provided with an air-tank similar to that on the locomotive, and for the same purpose.

193,283 TURBINE WATER-WHEEL. Theodore H. Risdon and William W. Tyler, Mount Holly, N. J.

A double water-wheel, the upper section of which opens into and surrounds the central shaft without interior dividing diaphragm or partition, and both sections of which receive the water horizontally on the outside, while the lower section discharges vertically or nearly so, and the upper discharges at an angle of 45 deg. There is also a cylindrical gate adapted to open upon the lower section thereof alone, or both sections together.

193,292. HARROW. Oliver Slagle, London, Ohio.

The harrow is provided on its forward edge with long inflexible loops which incline forward at an angle of 45 deg. or thereabout. The axle of a wheeled sulky passes loosely through these loops, and the front edge of the harrow is thereby depressed and the teeth forced into the ground as the sulky advances. There is also a lever mounted upon the axle or frame of the sulky, and the rear end of said lever extends beneath the front bar of the harrow, so that by depressing the front end of said lever the whole harrow may be raised from the ground. There is also a brace attached to the rear bar of the harrow and extending to the lifting-lever, whereby the elevation of the front end of said lever will depress the rear edge of the harrow. By these means the harrow may be raised entirely from the ground for transportation, or may be weighted with a portion of the weight of the running-gear of the sulky.

193,309. MECHANISM FOR SHIFTING DROP SHUTTLE-BOXES IN LOOMS. H. Wyman, Worcester, Mass.

Reciprocating rack-bars or jacks, under control of a pattern mechanism, are operated by lifters and depressors, as is usual in shedding mechanism. The racks mesh with pinions, each provided with a crank-pin. The main lever of the box motion is in contact with and is operated by the crank-pin of one of the pinions, while the auxiliary lever is similarly connected to and operated by the crank-pin of the other pinion. The pinions make only a half-revolution.

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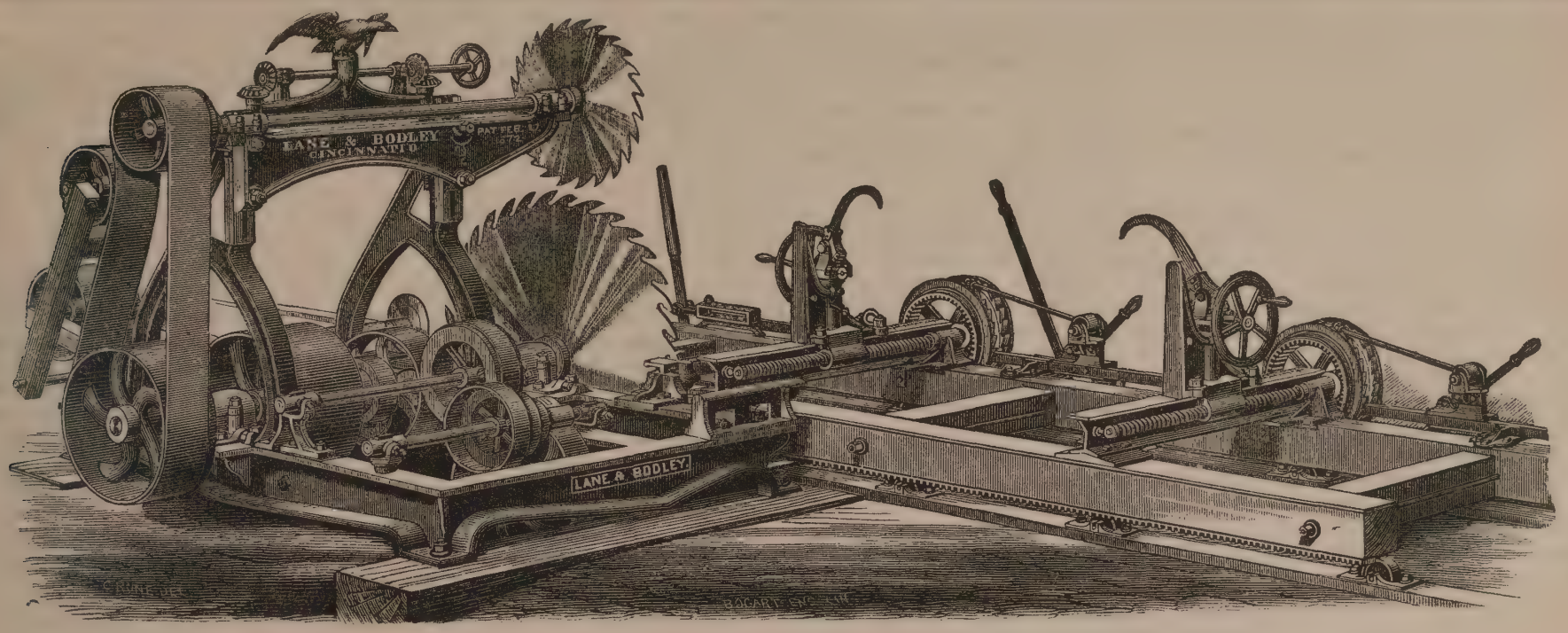


SAW MILL IMPROVEMENTS.

Saw mills were originally made very light in their frames, these being generally of wood ; but the times demand better quality of product, more care in sawing and more solid and better made machinery is necessary to produce it.

Lane & Bodley Co.'s saw mill is constructed on a solid iron frame of the I section in its several parts ; the feed and saw shafts are attached to this frame.

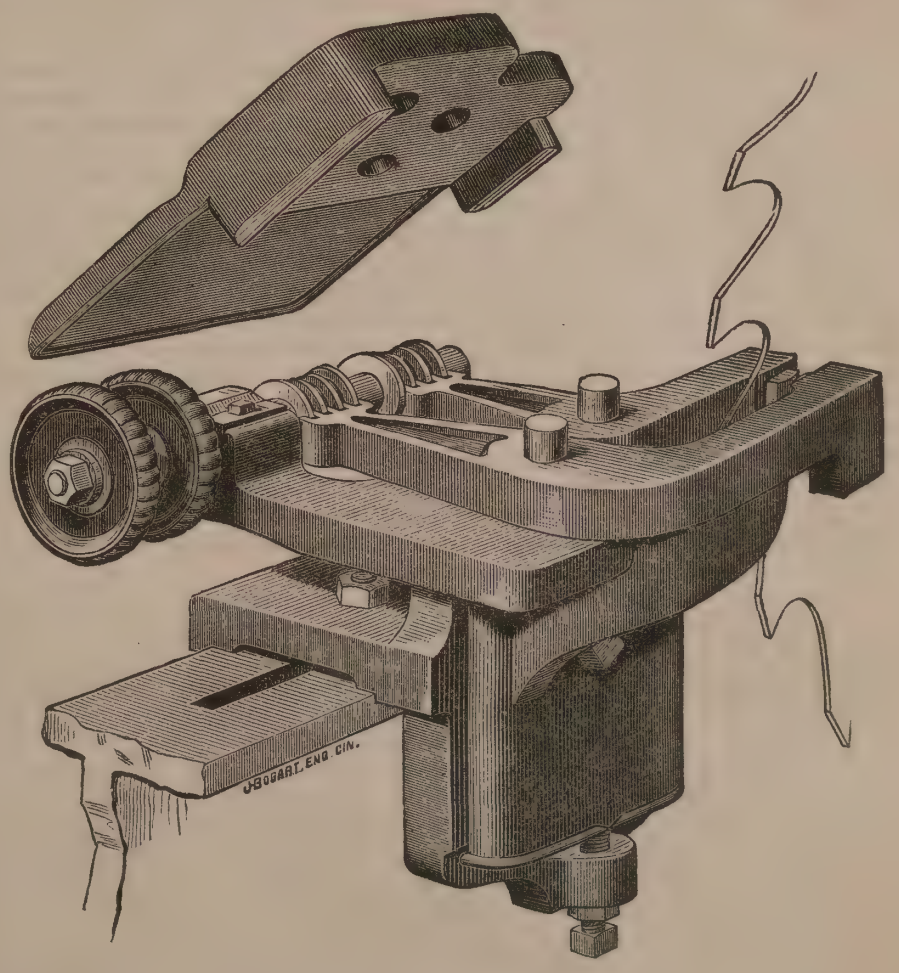
The mandrel is usually of steel ; some prefer forged iron. The lateral motion is taken up by a V collar in the centre, the box or bearing for which is held between pivots and which have rubber cushions between them and the adjusting set screws. This box is also adjustable vertically to take up the wear. We believe this is the only mill in the market which has an elastic fastening to the mandrel. In ordinary work the mandrel is rigidly held, for the rubber is very compact, but for extraordinary occasions the elasticity afforded is of great relief to the saw. The advantages of centre bearing is the relief to the main bearings of the usual collar friction and a division of the expansion of the mandrel both ways from the centre.

The saw collars used are of large diameter, and have bearing on the saw only at their outer periphery, as it is practically impossible to grind a saw true on the grinding machine close to the eye. The mandrel boxes are self-oiling, of a plan in successful use—using no wick or packing. The oil is kept in constant circulation, being raised by atmospheric action from the reservoir below, the rotation of the shaft producing the vacuum.

The feed is friction both ways, using one belt. The backing motion of the carriage is produced by the contact of a large paper-filled wheel, first upon the moving pulley on the mandrel and then on an iron friction wheel on the carriage pinion shaft. The feed-forward motion is transmitted through the belt on cone pulleys to the small paper friction working against the rim of the same pulley on the pinion shaft. The two shafts bearing the friction pulleys being held on one vibrating bar, one is on when the other is off, and so adjusted that neither may bear, and the carriage may remain at rest. This system permits a rapid movement of the carriage in either direction, the slip of the friction permitting safety at very high speed and sudden stoppage. The mill frame is provided with a roller stand and revolving disk, to spread the board from the log behind the saw. For large logs, where the saw plate to cut through must needs be of great diameter, and of great cost and of susceptibilities to damage in a higher degree than in the ratio of size, it has been proven more economical and fully as effective, to use an upper saw set slightly ahead of the lower saw, and adjusted to cut in the same path. This saw frame must be easily adjustable vertically, to accommodate the slightly varying diameter of the often changed lower saw. Saws are changed when dull, and seldom filed on the mandrel in the better managed mills. Lumber is seldom handled so wide as the two saws would cut, but the top saw is mainly useful in squaring up the round log. The upper mandrel is belted from the lower one, a tightener being necessary to bind the belt to the pulleys.

Saws must be guided on the rim. This mill has a very convenient and safe guide (see illustration). Two bell crank levers, one of the arms shorter than the other, have pockets or mortises to receive blocks of hard close-grained wood to bear on the saw ; the other, the long ends, have segments of worm or tangent-gear cut on them. These two cranks are pivoted a short distance apart. A short shaft, with one worm or endless screw fast upon it, moves one crank, and a short worm revolving loosely on the shaft and provided with a milled hand wheel, moves the other crank. By turning either wheel independently either jaw is moved ; but by turning both wheels together with one hand, the saw blade is moved to the right line in either direction.

The guide has a compound adjustment, horizontally along the frame, with bolt in a slot and vertically by a set screw. The upper surface of the guide forms a bearing for the slab or flitch. Cut shows cap removed.



The log is fed to the saw by a "carriage." This is generally of wood and stoutly framed and braced ; it is sometimes mounted on axles and wheels, or, as shown in the cut, the wheels are set on the sills and the track is on the carriage. When thus, the carriage is never obstructed by sawdust, bark, etc., and a firm support is always under the carriage where the strain of the saw cut comes. Both methods have their friends. V-edged rollers and track hold the carriage to a line. On the top of the carriage is placed the "head blocks" or set works.

These are an important part of the mill, as on their accuracy and convenience depends the quality and quantity of the product more than on any other part.

The inventors of the "Block" have experimented with the various mechanical principles for setting forward the log, and have settled on the screw. Its well known accuracy, which does not lessen by wear, and its positive hold, prevent the tendency of a springing log from drawing them forward, covering with these points the most important features of a "head block." The bearers in this block are of I beams—patented. The standards or knees are of cast iron, planed to fit the beams, and held on by jibs and bolts; on one side of the knee a pendant ear reaches to the centre line of screw and on which the nut is cast of Babbitt metal.

The only objection to the screw has been its slowness. In this the screw is double thread, of 1 inch pitch; on the end of this a pinion wheel meshes into an internal gear wheel, the outer periphery of which is a ratchet wheel. The gearing and pitch of the ratchet wheel are of such proportion that one notch of the ratchet is equivalent to $\frac{1}{16}$ of an inch on the beams; and a full throw of head lever forward and back moves the knees $1\frac{3}{8}$.

Objection to rotating shafts on account of the torsion of the bar, causing unequal movement of the knees, as they would be unequally loaded, has been so serious on mills for sawing long stuff as to cause the almost total abandonment of that principle for set work of such mills.

In this mill a bar is used with an end long motion, using the metal in its strongest shape. This rectilinear movement is converted into a rotary one by the pawls on the opposite sides of the ratchet wheel working into the ratchet wheel intermittently as the direction of the motion of the bar is changed; a short lever is provided by which the pawls are lifted from the ratchet independently, and a device by which both sets of pawls are released simultaneously. Coil springs hold the pawls on the wheel.

A lever at one end of the carriage, or at centre if more convenient, is provided with a gauge plate with index to aid the setter in making his work accurate without loss of time. The feed works have an arrangement of parts that will enable the setter to control the feed if desirable—this is customary in country mills.

The automatic self-receding dog is an original method of holding the log: it consists of a swivel mounted worm and segment of tangent wheel, in which is a steel hook for entering the log. The swivel is arranged to mount an inclined plane as it is swung around to position. When the hook is released the gravity swings the hook around from the track of saw and away from the place of the new log. This dog will hold the largest log or a 4″ scantling, and can be set on any diameter, so that the saw can cut within an inch of the knee. J. C.

THE TURBINE vs. WATER WHEELS.

We might divide the motors by which the force of falling water is utilized, into water wheels, hydraulic engines, and turbines; the wheels including those in which the water acts principally by its weight, the engines deriving their power mostly from pressure, and the turbines availing themselves more particularly of the speed. There are of course grades which merge the principles of one of these classes, with those of another.

The first and most primitive of water wheels is the flutter wheel—a simple axle with radial paddles that dip in the water and are whirled around by it. The Chinese scoop-wheel has a wooden axle with bamboo framework or arms, and basket work buckets. The Noria, or Spanish water wheel, has a shaft lying upon somewhat inclined frames without any notching whatever being made to receive it, the shaft itself having merely a slight groove to prevent endwise motion; and a "chock piece" on the inclined frame preventing the shaft from rolling down the frame. A development of these is found in the undershot wheel with straight radial paddles, and where the force of the stream is more confined, directed and utilized, by means of an apron which holds the water to its work, but which cannot, however, prevent its escape from the blades after it has acted through more than a very few degrees of the circumference; and hence but 35 per cent. of the theoretical power of the water is utilized. Bending the blades at an obtuse angle in their length, allows the water to strike them at a more favorable angle and keeps them submerged and acted upon for a longer period. The substitution. for the obtuse angled blade, of a bucket curved with suitable radius and inclination (determined by calculation, and *not* by experiment, which may be worth thinking of by those that sneer at theory), permitted the "Poncelet" wheel to develop as high as 60 per cent. of the theoretical power of the fall—a marked stride, and which already shows for this rude water motor five times the economy of force developed by the most improved steam boiler and engine.

At this stage the undershot is no mean aid to human exertions, most readily adapting itself to low falls and for such purposes as require but a slow motion, as for pumping, etc.

The overshot wheel, which has the marked disadvantage that its lower part travels in precisely the opposite direction to the water in the tail race, carries the water for a longer time than the undershot, and uses a high head and small volume to better advantage, especially when the pressure is uniform. But when the pressure falls, the overshot has the disadvantage of being curtailed in power, unless originally given too much head, which in itself is a waste. Again, in the overshot there is some waste, because much of the water leaves the wheel before the lower level is reached; and an additional disadvantage because, in leaving the wheel, instead of being forced away, it is drawn under, causing the annoyance of "back water." Still the overshot at full head can utilize 50 per cent. of the theoretical power.

The breast wheel uses a high head and small volume to about the same advantage as the overshot; and when the water level falls, the breast wheel can draw from the lower gate. It has this additional advantage over the overshot, that the spent water is forced away from the wheel. Its duty may be considered as about 70 per cent. of the theoretical amount; and it is decidedly the best of the water wheels proper.

As considered by Reuleaux,* the breast wheel is a toothed-wheel having, in place of a rack, a liquid pressure-organ, guided (in the breast) by a portion of the frame which carries the wheel. Its formula is $\left(C'\ C_z\ V_\lambda\right)^{\frac{c}{b}}$, C' being the shaft cylinder; C_z the wheel cylinder (C) with teeth (z) gearing into the liquid λ, which is coupled with the hollow guide (or trough) V, containing the liquid λ; the whole being mounted on c and driven by b. This formula would, if written more at length, be $C^{+}_{\ldots} \mid .. C^{+}_{z}$ $Q_\lambda .. Q_\lambda \underline{V^{-}_{..} + .. C^{-}_{=}}$, which expresses a machine in which a solid cylinder C^{+} (the shaft) is fastened with a key (|) to a solid cylinder C having teeth (z), gearing with a pressure organ, Q, which is a liquid (λ); this having a guide, V, which is negative (—) or hollow (the trough); this being connected crosswise (+) with a negative (—) or hollow cylinder (the bearing) which is coupled parallel (=) with the solid cylinder, C^{+} at the beginning of the formula. The line under the latter portion indicates which portions constitute the *frame work*.*

The inconvenience of erection of the gravity wheels is no small matter for consideration. Nothing could be more convenient than the turbine, especially where the cast iron globe penstock with draft tube, is used. The gravity or overshot wheel must have a diameter equal to the fall of water, that is, the "height of the head." Now if its peripheral speed exceeds $16\frac{1}{2}$ feet per second (the velocity of a body falling one second), part of its effect will be lost by its anticipating or overrunning the water. This gives but slow angular velocity or axial speed, and necessitates a train of multiplying gearing, with its attendant disadvantages of first cost, wear, liability to accidents and friction, especially where toothed wheels are employed; and where belting is used we have slip, causing loss of power and of regularity of motion. This question of belts multiplying the irregularity of motion is by no means unimportant, especially when the machinery driven is (like power looms, paper machinery, burr stones, etc.) of a class requiring peculiarly steady motion to prevent spoiling of stock. Belts which multiply eight fold the revolutions of the driving pulley, often intensify the irregularities of revolution also eight fold; because here a slip of $\frac{1}{64}$ of a revolution on the driving wheel may become a slip of $\frac{1}{8}$ of a revolution on the driven. The large size of the gravity wheel, and its necessarily exposed position, gives great liability to freezing up in winter; and as there is such constant alternation of wetness and dryness, cold and heat, by alternate exposure to water and to sun and air, we have iron wheels corroding and wooden ones rotting.

The necessity of large diameter in gravity wheels causes drag in the water at the bottom or delivery side, and consequently a high tide or a freshet affects them by back water.

The turbine wheel is, according to the nomenclature of Reuleaux, a screw pair $S^{+}_{=} S^{-}$ in which the water is the nut acting upon the wheel.

This being the case, we have reason to expect from it a performance more satisfactory and a duty of higher efficiency than where the water is simply an unconfined rack, with greater opportunity for slip without doing work. This expectation is fulfilled in practice by a very general rating of from 75 to 85 per cent. of the theoretical effect of the water. Its greater convenience has been referred to in a previous paragraph; and to the advantages named, we might add the exemption from irregularities caused by fluctuations in water level; the greater ease of attachment of a governor and of regulation thereby; freedom from choking by ice or other floating masses; less power absorbed in friction, &c.

The turbine is constructed almost entirely of cast metal, and a nearly perfect model once found by theory and experiment, gives uniformly excellent and nearly perfect results in all the wheels taken from it. Built up wheels have not this advantage, nor are they as readily repaired in case of serious accident. Cast iron rusts less than wrought, which is another point.

The excellent performance of the turbine in producing, after deducting the friction, so nearly the theoretical power of the water which drives it, gives us little reason to expect much if any improvement in its rating (at any rate under full gate); and we can therefore look for improvement only in simplifying and cheapening, while rendering it stronger and even less liable to choke, etc., than at present. G.

* Kinematics of machinery, § 126.

COMFORT, HEALTH AND DECENCY.

It is humiliating to reflect that the same age that witnesses the rapid transit by means of the "lightning express," and the marvelous interchange of thought along a dull, lifeless and immovable wire, should find our vehicles rumbling, thumping and pounding over cobble pavements so immeasurably inferior to the roads built by the Romans, two thousand years ago. The disagreeable fact remains, and will not "down" at bidding. We are not wholly civilized, nor altogether up, in some things, to the standard of centuries ago.

But it is not bad enough that we are unprogressive in such matters as roads and vehicles, there is a graver charge that can be brought against us, and that is, that we are lost to common decency, and neglectful of ordinary sanitary prudence, in one very important respect—the removal and disposition of fecal matters. The disgusting mode of removal by the pole and bucket system, still practiced in many cities, is a blot upon our character for decency; and is wholly inexcusable in view of the fact that science has provided us with a system of "odorless excavation," which leaves little or nothing to be desired on the score of convenience, comfort, cleanliness and thoroughness of work. As long as a "moonlight mechanic" is permitted in any city to ladle about his disgusting and unnameable material, and to cart and spill it about the streets; as long as it is permitted to hire one to wallow in the nastiness, and to send its nauseous odors upon the air we breathe—so long, we say, we are lost to a sense of shame and decency, and utterly undeserving the name of civilized. G.

* So far from these formulæ being complicated, heathenish, arbitrary symbols designed by the theoretical student to confuse the practical man, they are of the most simple and easily understood character, and express the fundamental nature of machines more readily than any other mode yet known. A general knowledge of such principles and formulæ would do much to rid the world of non-working mechanical devices; would enable new mechanical movements to be devised for given purposes, and substitutes or "alternates" to be produced for those already in use. Note the difference between the breast wheel and the turbine as expressed by the formulæ. It is safe to say that these two kinds of motors, generally classed together as "water wheels," never had their dissimilarity expressed more forcibly and clearly than by the formulæ.

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

TNE UTILIZATION OF BLAST FURNACE SLAG.

II.

A highly interesting suggestion, which opens a field of possibly very great value, in which slag may be turned to useful account in enormous quantities, was proposed by an English engineer, Mr. Bashley Britton, and was the subject of an interesting discussion at a late meeting of the British Iron and Steel Institute. This suggestion is to utilize slag for the production of the commoner varieties of glass. The following notice of Mr. Britton's plans and suggestions, abridged from one of the leading British technical journals,* will be read with interest.

"For perfectly white glass, such as crystal, it is obvious that slag can be of no value at all, in consequence of the amount of iron it contains, which cannot be eliminated, and would produce a green or amber color. For all glass in which a tinge of color is either needed or is not detrimental—and this includes an extremely large proportion of all that is made—a little iron does no harm; it is, in fact, often purposely introduced as an important element, for it is capable of replacing other fluxes, and so lessening the amount of alkali which would otherwise be required.

The iron master, with a different object, is always melting down precisely the same materials; he cannot produce his iron till he has first converted the gangue of his ore into glass; but he calls it "cinder," and gets rid of it as best he may. The cinder is not readily recognized as glass, because it looks like stone; but all glass will look like stone if cooled slowly from its liquid state. The cause of slag being so completely devitrified, is that it is too rich in lime and too poor in silica. The glass maker, however, has to buy this lime at five or six times the price of his silica or sand, while all his ingredients together cost him comparatively little more than the very large quantity of fuel he must burn, in order to bring them into the melted form in which the iron master throws all his glass away.

The question, therefore, to be opened out is, whether there may not, to a great extent at least, be a remedy for these practical anomalies. May not the manufacture of crude iron be so combined with that of glass, that the latter may be produced so cheap as to render it available for many additional uses, possibly more extensive than those to which it is at present applied? The only ingredients to be bought are sixty-five tons of common yellow or red sand, to be had anywhere, at a nominal price, and ten tons of common sulphate of soda, which may be had cheaply. The necessary fuel would be limited to what is needed beyond the surplus heat of the slag, to raise only $\frac{2}{7}$ of the glass to the required heat; and it is a question whether the greater part of even this might not be saved, by bringing down some of the spare gases from the blast furnace, and employing them with regenerators; if needed, they could easily be enriched with a little added carbon.

Against these items there would be a set-off for the cost of removing the 100 tons of slag, which must otherwise be thrown away. Besides this, another and considerable saving would arise, from the wear and tear of a glass furnace being lessened, in consequence of $\frac{4}{7}$ of the materials going into them being already fused. Under such circumstances the total cost of the glass, in a melted state ready for working, is seen to be so extremely small that it is hardly safe to venture to express it in figures; it scarcely amounts to the value of the commonest bricks per ton. Blast-furnace works, where pig iron only is made, frequently stand in pairs in isolated situations, with plenty of space around, on which glass works may be erected on any scale; and, in many instances, they might be built close up to the sides of the furnaces, and extended laterally away from the pig bed. In that case the slag might be run directly into a glass furnace, on the well known plan of Mr. Siemens, for continuous founding and working. Where there is insufficient room for this, the glass works might be at some distance, and the slag could be collected and conveyed to them in a state of fusion, in large covered ladles on wheels, similar to those used in some Bessemer steel works, where the molten iron is carried upwards of a mile to be poured into the converters."

Finally, we will allude to one of the most interesting, and certainly the most novel, applications of blast furnace slag that have been made, and which appears to be steadily growing in popularity. We refer here to the method of converting slag into a material resembling wool, which is accomplished by permitting a jet of steam or air to impinge upon a thin stream of escaping slag, in a suitably arranged chamber, by which it is blown into the finest filaments. In this condition the slag bears a close resemblance to cotton wool, and has been not inaptly called mineral wool (or cotton). So far as we can learn, the first suggestion to utilize this material, which is sometimes formed accidentally at the iron works, when a leak in the furnace lining permits of the escape of the blast through the crevice, originated with Mr. John Player, to whom letters patent of the United States were issued May 31, 1870.

The high non-conductibility of this material, and its peculiar form of aggregation, which permits of its retaining an enormous quantity of air within its interstices, thus enhancing its virtue in this regard, naturally suggested its employment as a non-conducting lining or covering in a variety of situations, a suggestion that was commended by a favorable report of a committee of the Franklin Institute, which, in the same year, after having instituted a series of comparative trials, reported it to be superior, in non-conducting value, to felting, one of the best and most popular non-conductors in use. The process of its production has been described as follows:—"The slag is conducted from the furnace, through an iron trough lined with ashes and sand, to the spot where the wool is to be blown. Here the slag is permitted to drop from the trough in a thin stream. Below the orifice of the trough, a steam pipe with a crescent shaped opening, is so placed that the issuing steam impinges directly upon the stream of slag, thereby blowing the same into a wool-like condition. This slag-wool is then stuffed between pipe and around outside lagging, and held in position by means of strips of linen orcommon pack cloth. If the surface to be covered is large, in order to give greater firmness, strips of hoop iron are placed at intervals over the wool in the direction of the axis of the boiler or pipe to be covered, and held in position by wire, the whole being afterwards covered with pack cloth."

Mineral wool has a very short fibre—cannot be felted in the usual way, as cotton or hair—and its application to steam-pipes, etc., is somewhat difficult, because it has to be stuffed around the pipes and under the outside covering. In this respect cements and hair-felts have the advantage of easier application. To overcome this difficulty Mr. Elbers has invented a process, whereby the mineral fibres are collected—as they settle down by their own gravity—in boxes, which have the dimensions of the felting to be made. The mineral wool is then, without previous handling, pressed down in these boxes to a desired thickness. The sheets thus gained—especially if *glued* or *sized*—are of sufficient consistency to be wound around and fastened on steam-pipes by means of twine or wire, or pipes may be first coated with water-glass (silicate of soda or potassa) or any other stickey substance, and then the mineral wool sheets may be put on. Felting, paper or canvass can also be lined with these sheets on that side which is to be in contact with heated surfaces.

These incombustible feltings, made entirely of mineral matter, and yet looking as soft and fine as cotton wadding, are a great improvement upon the crude material, on which the writer as committeeman passed favorable judgment at the Franklin Institute in 1871.

Slag-wool is a very poor conductor, and can stand very high temperatures, is not affected by moisture, and, as may be seen from the simple means by which it is obtained, costs but little. The uses to which this material is now applied, here and abroad, are very numerous. In the large English cities and towns, as London, Manchester, Leeds, Hull, Newcastle-on-Tyne, and other manufacturing localities and seaports, where it is sold under the name of silicate cotton, it is employed on board of steamships, on locomotive boilers, steam pipes in manufactories, etc., to prevent radiation of heat; it is also advantageously used to prevent freezing in water pipes, cisterns, tanks and hydrants; to prevent cooling and condensation; to arrest the spread of fire; to deafen walls and floors in dwelling houses; to line ice-boxes, refrigerators, cold storage houses, fireproof safes and vaults, etc.*

The foregoing generalities will suffice to give a notion of the variety and importance of the uses for which this now practically refuse stuff has been found suited, and of the interest which attaches to this special instance of a waste product, which the progress of our industries must sooner or later turn to useful purposes in the arts.

W.

STENOGRAPHY A NECESSITY.—At an examination before Register Ketchum in New York, in the matter of the bankruptcy of Daniel Frey, Isidor Frey and Jacob L. Haas, counsel for the assignee proceeded to take down the examination by a stenographer, whereupon counsel for the bankrupts objected to the proceeding, unless counsel for the assignee would supply him with a copy gratis, on the ground that the register is obliged to have the depositions taken in common writing, so that the counsel might see clearly the question and answer, in order to conduct a cross-examination. The register overruled the objection, holding that the art of swift writing was too valuable to be parted with, and that the question presented was, substantially, if any party may at his will, forbid stenography upon the trial and compel common writing. Counsel for the bankrupts objected to the decision of the register, and the question was certified to the United States District Court. Judge Blatchford concurred in the opinion of the register.

*Iron, viii, 396.

*This product is manufactured in the United States, under above named patent, by Alex. D. Elbers, 26½ Broadway, N. Y., who is also the patentee and owner of several patents for producing mineral wool with the assistance of mechanical projection of the slag, to free it from shot, and for making feltings, sheetings, etc. Since 1876 about a million pounds of mineral wool have been made—under authority of Mr. Elbers—by R. D. A. Parrott, at the "Clove" Furnace, Greenwood—on the Erie Railway. In Germany mineral wool is known as slag wool, was first made at the George-Marien Huette, Osnabrueck, in 1871, and some years later at Mr. Krupp's furnaces; from whence it was also sent to England, where it is now extensively used and known as "silicate cotton."

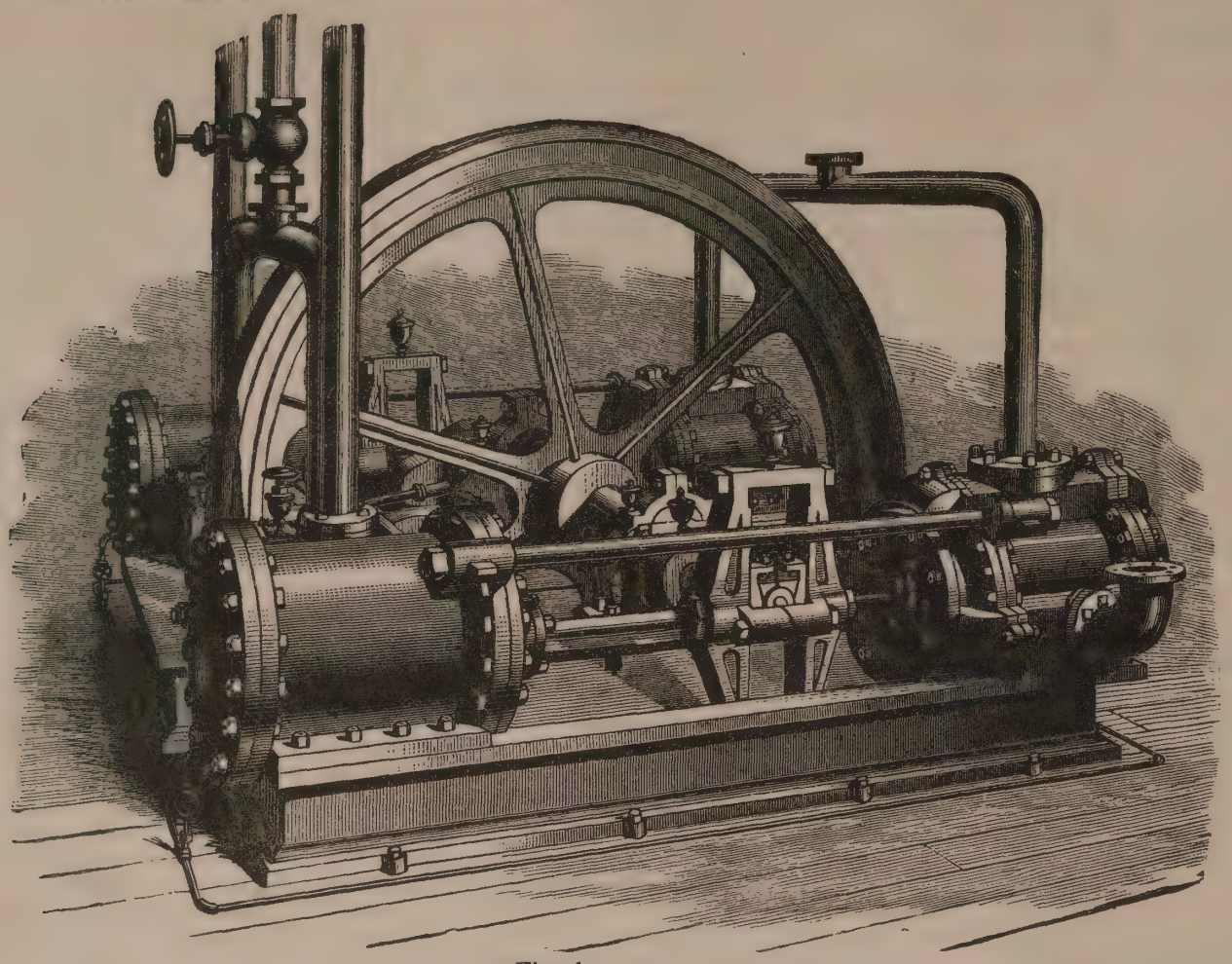


Fig. 1.

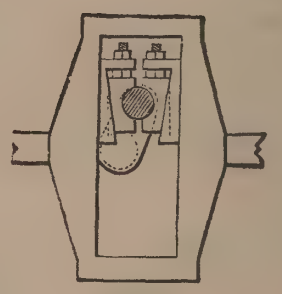


Fig. 2.

CLAYTON'S AIR-COMPRESSOR.*

The extending demand for compressed air as a motive power to work rock-drills and other machinery in mines, to sink caissons for foundations, and for many other purposes where steam power could not be used to advantage, has made it highly important to provide the most perfect and economical compressing machinery.

A head of water has been extensively used for this purpose in mines. The most extensive application of this kind was made at the Italian end of the Mont Cenis tunnel, where ten hydraulic rams of peculiar but very ingenious construction furnished air, at a pressure of five atmospheres, to drive the rock-drills. The exhaust from these furnished fresh air to the workmen, at the same time carrying off the heat and smoke produced by blasting.

These machines not proving very economical, they were replaced by double-plunger pumps, driven by overshot water-wheels. To avoid loss by clearance spaces, the pump cylinders were filled with water, which then formed the real compressing piston, at the same time absorbing the heat generated by the compression. These machines furnished about three times as much air, for the same water power, as the rams, and their cost was only about two-thirds that of the latter.

The large body of water in the compressing cylinders, rising and falling with the stroke of the piston, did not admit of great speed; but the economy of the latter being evident, so-called dry compressors were tried, which have now come into general use. In these the heat generated by compression is sometimes absorbed by a water-jacket round the cylinder, and even the piston and rod may have water circulating through them for this purpose. The metal thus intervening between air and water does not favor a lively conduction of heat, and a great amount of circulating water is required.

In other compressors, small jets of water are injected into the cylinder, thus giving the additional advantage of a slight lubrication; the air is also charged to some extent with aqueous vapor, making it more salubrious when it is afterwards to be used for ventilating purposes. The heat generated in compression is not only objectionable in heating the cylinder, piston, rod, &c., causing greater friction and wear, but also entails a direct loss of power.

The cylinder, when highly heated, will cause the entering air to expand, thus diminishing the weight taken in; and when the compressed air is led away to a reservoir or through long pipes, &c., it gradually loses its heat, declining correspondingly in pressure. When the cylinder is kept cool, a full supply of air is taken in, the temperature of which, when compressed, is not sensibly increased, hence no loss in pressure can take place afterwards. When it expands on being exhausted from the rock-drill or other machine, it is considerably cooled, and its vapor is condensed, which, in deep mines or in tunnels filled with the heat and smoke from blasting, is an important advantage.

Figs. 1 and 2 represent Clayton's Duplex Air-Compressor, which is constructed in accordance with the modern principles enunciated above. The steam and air-cylinders are bolted to a bed-plate of ordinary construction, the steam piston communicating the power directly to the compressing piston. The cranks are connected at right angles to avoid a dead centre; this arrangement also enables one piston, during the first half of its stroke, when its own work is slight, to assist the other in finishing the last half of its stroke, against the maximum air pressure. To attain further equalization of work against the varying resistance of the compressing pistons, a fly-wheel is keyed on the centre of the shaft.

Instead of a connecting-rod, a yoke is used, in which the sliding-block connects with the crank-pin. This yoke is represented in Fig. 2, and the sliding-block is fitted with Clayton's adjustable journal-boxes, by which any wear, either on the crank-pin or in the yoke, can readily be taken up. The yoke runs on a guide (adjustable by set-screws) placed under its lower end, carrying its weight and that of the piston and piston-rod; thus the weight and wear are, to some extent, removed from the under side of the cylinders, which will work longer without reboring. The compressors have a stream of water running in with the air, taking up the heat, lubricating the piston, and to some extent filling up the clearance spaces, leaving only very little air to expand back when the piston begins its return stroke.

The compression piston is packed with manilla hemp, saturated with a composition (supplied by the manufacturer) which makes it very elastic and durable, and will also lubricate the cylinder should it be required to work without water.

It is claimed that this compressor will do a comparatively larger amount of work than others of the same size, on account of an important new feature in the construction of the valves. A valve opened by pressure will, at the moment of starting, require a greater pressure upon its under side than upon its top, the area of the latter being so much greater; but when once started, this difference of course disappears. Mr. Clayton found that when compressing air to 60 lbs., the valve would not open before the pressure in the cylinder reached 90 lbs. (This seems rather excessive.) As this caused considerable loss of power and efficiency, a special arrangement is made by Mr. Clayton to start the valves at a certain pressure. This is effected by a few short levers inside the box containing the valves, which levers are moved by an axis enclosed airtight in a packing-box. The axis is worked by an eccentric on the fly-wheel shaft, which can be adjusted to start the valves at any required pressure.

An important advantage of the duplex system is that when one compressor should need repair, it can be disconnected and the remaining one run so much faster, enabling the work to be continued without delay. The engineer in charge of the Fourth Avenue improvement and the tunnel in Ninety-second street, New York city, had a No. 5 Clayton Duplex Air-Compressor in use, and testifies that air sufficient for seven rock-drills, two steam-pumps, and two hoisting-machines, was furnished by a consumption of three and a half tons of coal in twenty-four hours, and that its general performance was entirely satisfactory.

J. HAUG, M. E.

* Manufactured by James Clayton, 14 and 16 Water street, Brooklyn, N. Y.

THE MANUFACTURE OF STARCH.

Starch is an organized substance having a composition identical with that of cellulose, and is one of the most wide spread compounds of the vegetable kingdom, occuring in wheat, corn, rye, barley, peas, rice, beans and other grains and seeds, in potatoes, and in the fruits, stems and roots of many other plants. To the eye it appears as an amorphous white powder, but viewed under the microscope, it is found to consist of distinct granules, the size and shape of which vary somewhat, according to the source from which it has been derived. The individual starch granule, again, is not homogeneous, but appears to be made up of a great number of laminae, which, as they are uniformly thick or the contrary, make the granule approach the spherical or lenticular form, as the case may be.

Starch preserved in dry air will contain ordinarily about 18 per cent. of water, and in moist air, about 35 per cent. It is completely insoluble in cold water, alcohol, ether, ethereal and fatty oils. At an elevated temperature it is converted into the soluble modification called dextrin. When gently heated with 12 or 15 times its weight of water, no change is preceptible until a temperature of about 130° or 135° Fahr.,

when the granules begin to swell, and if the heat be continued, the granules burst, and the result is the translucent mass with which we are so familiar as starch paste. By continued boiling starch dissolves in water, one part of the starch dissolving in about 50 parts of water. Alkalies and dilute acids act upon starch even in the cold, and bring about the swelling and partial destruction of the granules. It may be completely dissolved in boiling water containing a slight percentage of oxalic acid. It is dissolved in the cold by concentrated nitric acid, but is violently decomposed if heated with this acid. The common starch paste, although quite stable in the air, gradually sours, by the formation of lactic acid.

"There are but few historical notices of starch.* Pliny speaks of it as being made in the island of Chios. Nothing more is known of its history until the time of Queen Elizabeth, when it was in use for stiffening the enormous ruffs of that period. In the last century the manufacture attained considerable importance in England, and starch was applied to numerous uses in the arts, in medicine, and for purposes of the toilet. In the reigns of Annie, and George the I, II and III, the use of any other material as a substitute for starch in any of its applications was most strictly prohibited, under severe penalties. About the close of the century its production was a subject of no little interest. In 1796 the Society of Arts awarded a prize medal to Mrs. Gibbs, of Portland, for her discovery of the Arum Maculatum as a fruitful source of it, and the starch thus obtained was afterward sold as Portland arrowroot. The same year Lord William Murray discovered a method of extracting it from horse chestnuts.

Starch is manufactured in different countries from those vegetable productions which yield it most cheaply. In the United States, Indian corn and potatoes are most commonly used. The application of the former to this use was patented by James Colman in 1841. By this process starch was first made from corn in the United States."

Only a few plants contain starch in such quantities as to permit of being extracted profitably therefrom, on the commercial scale, the commonest commercial sources being, as above stated, potatoes, corn and rice. Potatoes form one of the greatest sources of starch here and elsewhere, and enormous quantities are annually prepared therefrom. The operation of manufacture is described as follows:—The dirt on the potatoes is softened by soaking, and is then washed off by passing them through a revolving sieve, against a stream of water. The potatoes are then grated, and the pulp washed on a sieve, the starch passing through with the water. The remainder called pomace is allowed to go to waste, though certain quantities of it are occasionally utilized, after boiling, as food for hogs and cattle. The starch and water is run into large tanks, when the starch gradually settles to the bottom, the water being then drawn off. It is then placed in a smaller tank, more water is mixed with it, and again allowed to settle. Such portions of the pomace as have passed the sieve into the vat, will then be found on the upper portion of the starch after settling. This is removed, and placed in the next vat for repurification. The good starch below is taken to the drying room, where it is placed upon the highest of a series of racks, falling to the lower ones as it dries and crumbles to pieces, being completely dried when it reaches the floor, from which it is collected for packing. One bushel of potatoes will yield, it is said, from eight to nine pounds of starch, the quantity in exceptional cases running as high as eleven pounds. The process of making starch from corn, which contains it in large quantity, and which yields a product of particularly fine quality, is somewhat different from that above described.

The grain is first soaked in water until it is quite soft, which has the effect of preventing the gluten, &c., from being ground as finely as it would otherwise be. After grinding it is washed through different sized screens, the last being made of fine bolting cloth. This separates a large portion of the gluten as well as the bran, but some little will still pass through with the starch, and must be separated by other means. One plan is to drain off most of the water, and then allow the mass to ferment, adding yeast to hasten the action. This process renders the gluten soluble, and it is then readily washed out. Another method is to dissolve it out with a little alkali; and a third, to separate it by difference in its specific gravity.

To do this, the water from the sieves is run into vats, and when the starch has settled, the water which still contains considerable of the gluten, is drawn off. To carry out this process properly, the vats must be so arranged that the water may be drawn off as fast as the starch subsides. The starch is then again mixed with water, thoroughly stirred by steam or other power, and the water again drawn off. It is a well known fact, that corn contains a notable percentage of oil, and investigation has proved that the starch lying nearest the outside of the grain, is somewhat contaminated with it, while the deeper lying granules are quite pure.

After the starch has settled, experience has also shown that the purest will be at the bottom, while that contaminated with oil will be above, and the uppermost layers will be mixed with considerable fine gluten. The different grades are separated by stirring them in separate portions of water, and siphoning them into different vats, where they are washed and, if need be, purified. When the gluten is separated as completely as possible, the starch is mixed with water, and pumped or siphoned into the filters, which are composed of wooden boxes, with perforated bottoms, lined with fine linen duck. When the filtering is complete, the starch in the box is covered with a dirty film of gluten, which is scrubbed off and reworked, either separately or by mixing with other starch in the earlier stages of purification. The starch from the boxes is then cut into cubes and placed in the drying room (upon bricks) until they become dry and solid. After coming from this room, the cubes are covered with a fine yellow crust, which is scraped off and reworked; they are then done up in packages, and thoroughly dried in a hotter chamber. Here the starch takes on that peculiar prismatic form in which it is generally seen, and which renders it impossible to do up a package of starch in the same package after it has once been opened; for the prisms, after falling apart, cannot be brought back into their old positions. Sometimes the starch is packed at once without paper.

Of the uses of starch in the arts for the sizing of paper, the dressing of textiles, &c., and in the household for the stiffening of dress goods, it is quite unnecessary to speak. For these and many other uses enormous quantities are annually consumed. It is obvious, however, that much of the beauty and quality of the articles treated with it will depend upon the purity of the starch employed in the treatment, and that therefore the quality of this commodity, where it is to be used, is a question of first importance.

In this country the manufacture of starch as an article of food, and for domestic uses, has attained enormous proportions, and a high degree of perfection. One American establishment, that of the Messrs. Duryea,* having acquired a world wide reputation, not only for the extent of its manufactures, but also because of the absolute purity of their products.† The works of the Messrs. Duryea have a capacity of about fifty tons daily production, and their products, which will be recognized under the names of maizena, satin gloss, superior starch, &c., are largely employed at home, and are affirmed to have, to a large extent, superseded the celebrated European productions. The success of this establishment is entirely due to the scientific methods pursued in the manufacture of its goods, aided by the extensive capital of the company, which has enabled it to elaborate a system of improvements in the manipulations of its manufactures, securing for them the character of unrivalled purity and strength.

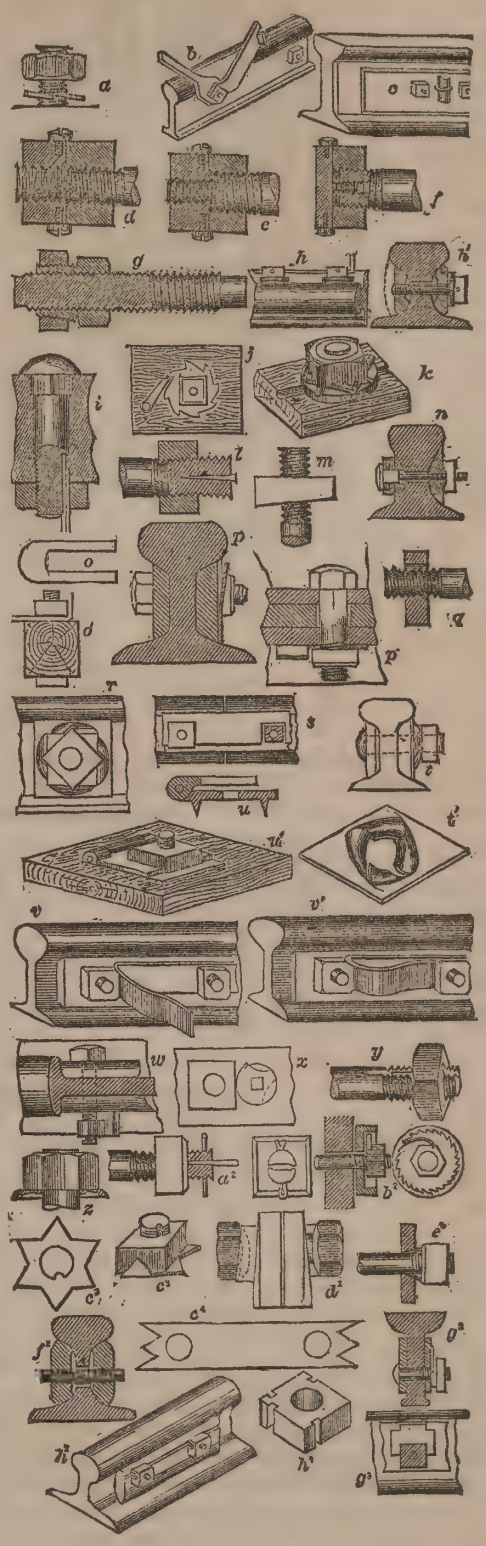
W.

*Starch, a Brief Sketch of its History, etc. (Duryea) 38 et seq.

*Glen Cove Starch Manufacturing Company, Glen Cove, L. I.

†This assertion is based upon the analyses of Profs. Lancaster and Genth, and upon the chemical examination of samples purchased in open market by the writer.

NUT-LOCKS.



Among the innumerable contrivances for securing and preventing bolt-nuts from working loose by the jarring and trembling of machinery, the following are most worthy of note. Most of them are American devices, though some of them are foreign. Very little description is necessary, since the devices are very simple, and can easily be understood from the drawings. The illustration is "Levytyped" from *Knight's Mechanical Dictionary.*

a has a washer cut obliquely, forming edges which cut into the nut and bar.

b consists of a plate which is fitted between the two nuts of the splice bar.

c has a plate fitting over the nuts and held by a staple and key.

d and *e* are right and left handed check-nuts, one being smaller than the other and allowing the smaller to be slipped over the larger; they also have set screws at either side.

f consists of an interior left-handed screw with its head forced against the face of the outer nut.

g consists of a conical screw whose longitudinal slits allow it to be forced down on the bolt screw by the outer nut.

h and *h'* consists of a through-pin which pierces the nuts.

i consists of a feather which is fixed into a longitudinal groove in the bo't and into a spine-way in the nut.

j consists of a racket-washer and a click, with the nut partly imbedded in the washer.

k consists of pin contrivances which enter grooves in the washer and nut.

l consists of a spreading wedge inserted into a split bolt.

m consists of an unequal-sided washer which causes one side to imbed itself into the object, and thus offer resistance to the screw.

n consists of a concave-faced nut, which fits on a convex seat on the splice bar or washer.

o and *o'* is a bifurcated washer with the legs bent up against the nut.

p and *p'* is a split washer, one side bracing against the nut and the other braced against the splice bar or washer.

q shows a gravitating nut, heavier on one side, and thus preventing turning.

r consists of a winged washer which springs against the sides of the nut.

s consists of a notched plate which slips over recesses in the nuts.

t and *t'* consists of a washer with spring wings which hold the nut.

u and *u'* is a hinged washer which holds the nut.

v and *v'* is a spring which is braced against the nuts.

w consists of a nut with a gravitating extension piece.

x consists of a cam which braces against the nut.

y consists of a grooved nut and bolt, into which a wedge may be inserted.

z consists of a nut which is forced upon a yielding washer.

a^2 consists of a split bolt and a wedge held by a key.

b^2 is a nut with internal ratchet and a spring click on the bolt.

c^2 c^3 and c^4 show the so-called Noblet washer, some of whose points can be turned up against the washer and others down against the object, if desired.

d^2 is the Nicholson (1852) bolt, with a hemispherical bearing surface and nut.

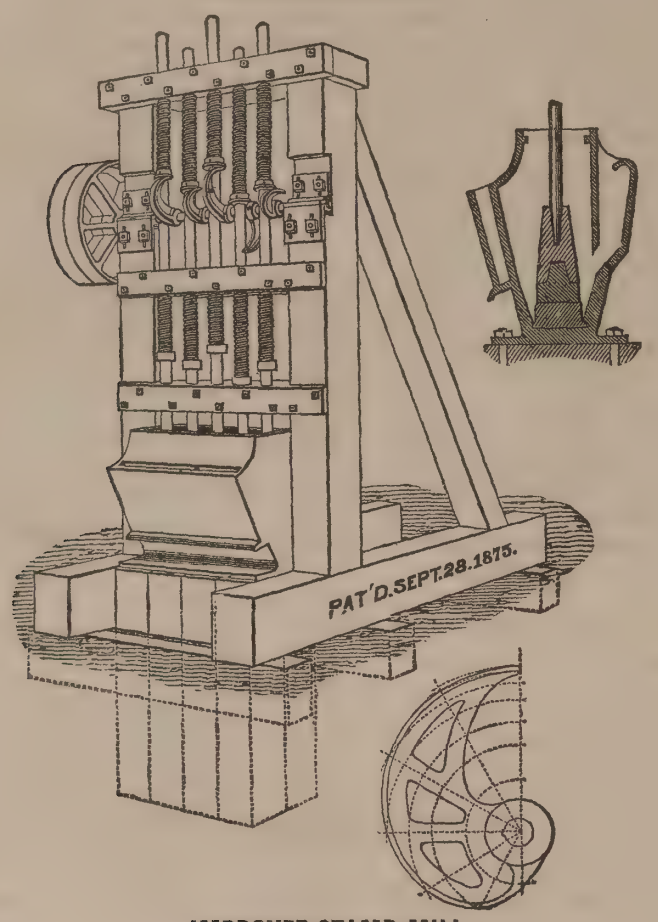
e^2 shows Adams' wedge-shaped washer (1856.)

f^2 consists of a right and left ended screw bolt.

g^2 g^3 consists of a washer beneath the nut, with a tip which projects into a slot in the splice bar.

h^2 consists of a washer slip with a piece turned up to form a key.

h^3 shows the grooved nut. H. T. W.



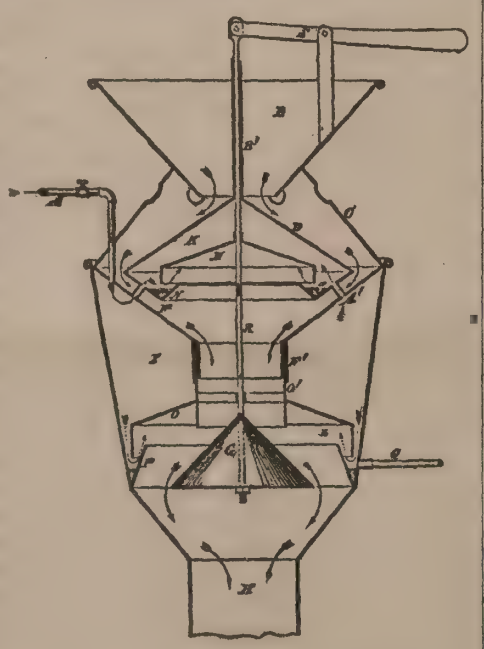
IMPROVED STAMP MILL.

The cut shows a very important improvement in quartz crushing mills, in which the weight on each stamp is substituted by a spiral spring; the cam being so proportioned as to render uniform the amount of work done by the machinery in compressing the springs. The mortar is seen in section at the right hand side. The mill is much lighter than where weights are used; its force is more adjustable, and the parts are more readily transported in mountainous countries. The makers are Ferguson & Jones, St. Louis, Mo. G.

IMPROVEMENT IN WHEAT-STEAMERS.

(Patented November 14th, 1876, by James W. Price, of Michigantown, Ind.)

The object is to prepare wheat for grinding according to its condition—if too dry it may be moistened, if too damp it may be dried, or it may be warmed in very cold weather.



The apparatus is shown in a vertical section, is intended to be suspended between the stock-hopper and the hopper on the stones, so that the grain may be prepared for grinding as it is used. Steam is supplied by the steam-pipe A, leading into the interior of the apparatus. B is a hopper, into which the wheat or other grain is run from the stock-hopper, passing thence, as indicated by the black arrows, on to the conical diaphragm D, and passing down between it and the perforated shell C on to the funnel-formed plate F, and thence down on to the cone G and out through the pipe H to the stones. In its downward passage from cone D to funnel F, it will be observed that the wheat is turned over—that is, the grains which were on top in descending D will be at the bottom in descending F, and vice versa.

Steam entering through pipe A fills the chamber I, and passes through short pipes A' into the chamber K, thus heating the grain as it passes over the plates D and F. It may be discharged at once into the stones, if the object is only to dry or warm the grain. In its exit it passes through the chamber L, being further heated by heat transmitted through plate O. The lower part of the chamber K is formed by a hood, M, terminating below with a vertical flange, which fits into the angle N. In like manner the top of chamber L is formed by the hood O, connected with a tube, O', forming, with the double plates at the tubular termination F' of the funnel F, a slip-joint, and terminating below with a vertical flange, which fits into the angle P, from which a drip-pipe, Q, is extended. The hoods M and O, as well as the cone G, are fastened to a rod, R, passing through the middle of the machine, and actuated in raising or lowering by the lever S. The rod in passing through hopper B is inclosed in a tube B'.

The apparatus is operated as follows:—the admission of steam is regulated by a stop-cock in pipe A. It at all times fills the steam-chamber I and K. If the object is merely to dry the wheat or warm it, the rod R is lowered, bringing the flanges of hoods M and O into the angles N and P, filled with water of condensation, and cutting off communication between the steam-chambers I and K, and the wheat passing down through the interior of the apparatus. Should, however, the purpose be to moisten the wheat, the rod R should be raised, elevating the flanges of the hoods above the water in the angles N and P, which cannot accumulate beyond the pipes A' and Q, and leaving an open communication for the steam to flow under the flanges into the interior of the apparatus, as indicated by the dotted arrows, where, mingling with the wheat, it is condensed and moistens it. It then passes to the stones to be ground. It will be observed that, in passing, the wheat is first dried, and then moistened. The steam is introduced at the bottom of the apparatus, in order that the wheat may not be dried after being moistened.

WIRE WORK.

Of late years wire has been largely employed in the production of a great many articles for use and ornament, yet no substance is so largely manufactured with less use of machinery, most of the work being done by hand, aided by a few simple mechanical contrivances. The chief exception to this is in the production of wire cloth for screens, which is woven on looms, as is any textile fabric, the pieces being sometimes six feet wide by one hundred and fifty feet long. Floral designs for the arrangement of flowers for funerals, marriages and festive occasions are made in almost endless variety, but almost exclusively by hand. The patterns are drawings on a table of plank in whole, or in parts by sections, and around the curves and at the angles pins are inserted, around which the wires are bent, the larger or foundation wires being secured by solder and the framing wires by very fine annealed wire wound about the intersection. A pair of pliers and a pair of cutting nippers seem to be the principal tools required, with rolls for forming circles and corrugated rolls for crimping the wire when required. The finished articles, when not too large, are painted by dipping in a bath of thin paint and hung up to dry. The whims of taste and a desire for novelty make a ceaseless demand on the manufacturers of this class of goods. This demand requires some artistic talent and considerable skill, but most of the manipulation is merely mechanical.

The woven wire mattress is no exception to the ordinary rule of wire work—the absence of intricate machinery—notwithstanding its appearance of textile construction. A close examination of one of these beds will show that it is composed of strands of wire in spiral form, like a very open coiled spring, the strands merely interlocked by passing one through the other. At first these spirals were made by running through a rotating spiral die and then run into each other, or one screwed into another, by hand. An improvement, however, forms the spiral and inserts it at the same time by the use of carrying friction rollers, an attendant guiding the progress of the interlocking and starting the next into place. It is simply boy's work, performed with great rapidity, the only preparation being a supply of tinned wire on a reel, and the only tool required being a pair of cutting nippers. The result, when properly secured in a frame, is a most comfortable, lasting, and cleanly bed, combining the advantages of the spring bed and the costly hair mattress. J. H. L.

WEIGHING MACHINES.

Of all the physical properties of matter, weight appears to be the most definite and unalterable, and is, in fact, the equivalent of mass and the true standard of measurement, comparison and computation. We must not omit to note that the emblem of Justice is a pair of scales. As we popularly understand the term "weight," it means the measure of attraction of the earth for the mass or matter in any given body; and any device for ascertaining the amount of such attraction may be termed a weighing machine.

We shall not here go into the question of weights—that is, the units of weight-measurement—but shall consider the means employed to ascertain and indicate weight as we know it.

Doubtless the first mode of weighing was by simple "heft"—as much as a man could lift in one hand, or hold out in one hand, or with both hands, &c. The difference in men's strength doubtless led to comparison of "heft" with some standard, as a stone; and later on, some sort of lever device came into play. The inference drawn from modern tendency would be that the two-pound balance* on a lever of equal arms preceded the steelyard (the Roman *statera*) or lever of unequal arms and but one pan. Pliny says that the balance was invented by Phidon of Argos; Gellius ascribes it to Palamedes. But at a time supposed to be about 1860 B. C., Abraham "weighed out four hundred shekels of silver, current money with the merchant," to Ephron the Hittite, in payment for the cave of Machpelah.†

The steelyard or unequal-armed lever is supposed to be, like gunpowder, printing, the mariner's needle, &c., the invention of the Chinese. It is not found in the ruins or inscriptions of Thebes or Beni-Hassan; but in the ritual of the dead of Hennefer (who was superintendent of cattle under Seti I., about 1350 B. C.) we find an inscription giving a picture of the weighing of the heart of the dead before Osiris in the Hall of Perfect Justice; and here the steelyard is the weighing instrument. Strangely enough, it is what we know as the Danish steelyard, having a fixed counterpoise and movable fulcrum.

* Lat. *bi-lanx*, with two plates.

† There were in Egypt in ancient days, as now, public weighmasters in all the markets, this being the peculiar province of the priests until the monopoly was removed by the Romans. There were also public weighmasters in Greece; the weights were rings of metal.

We should, perhaps, properly first consider the balance or "pair of scales."* The principle which this device holds in common with the steelyard is that in a lever of the first class the product of one weight by its distance from the fulcrum is opposed to the product of the other weight by *its* distance from the fulcrum. But in the balance the lever is purposely made with equal arms, so that to weigh any number of units—as pounds—an exactly equal number must be in the opposite scale. We might say that there are two classes of operations in the use of scales—*weighing* and *weighing out.* In the first case a body of unknown weight is determined in weight by placing in the opposing scale known units until a "balance" (or level position of the line connecting the points of support of the scale pans) is attained. In the second case, or "weighing out," a known weight is placed in one pan, and some of the material of which we desire a given mass is carefully added until the balance is reached.

In the construction of the balance, if the centre line of gravity of the beam pass through the point of support or fulcrum, the beam will have "indifferent equilibrium;" if the centre line pass above the fulcrum, there will be "unstable equilibrium." In either case the balance will be useless. Length of beam tends to accuracy by increasing the leverage and thus rendering any error more perceptible; but it is also essential that the beam be both light and stiff. These points are gained in the beams of the finer balances by making them of two hollow cones joined at their base, or by constructing them like the walking-beam of an engine—a trussed trapezium. The line connecting the points of support of the scale pans must pass *through* the central fulcrum, and not under it, as in the latter case the sensitiveness would be greatly diminished under a heavy load.

Borda s system of testing—or of weighing out correctly on a false balance—is to balance the weights in pan A by any material in pan B, and then to weigh out in pan A sufficient material to balance the contents of B. It is evident that by this means, no matter how inaccurate the scales are, you may (if you *know* of their inaccuracy and the *weights* are true) weigh with perfect accuracy. To weigh accurately on untrue scales (having correct weights), place in pan A the article to be weighed; balance it by any convenient mass in B; and then, removing the material from A, put sufficient weights in A to balance the counterweight.

The balance with sliding weights was invented by the chemist Berzelius.

To test the correctness† of a balance, put into each pan one of two standard weights known to be equal. Should one of these equal weights appear heavier than the other, the scales are untrue. The lighter the weights are, the more accurate the test.

The steelyard, with its more modern development, the platform scale, depends for its accuracy upon that of the sliding weight and of the graduations on the beam. To test it, see that the beam stands level when the rider is at 0. If you have a number of standard weights, known to be correct, see that the weight of each of them, and of every combination thereof, is correctly indicated on the beam. If you have no standard weights, weigh out, as per the beam, a number of quantities (say 2½, 5, 10, 20, 25 and 50 units) of any convenient material, and, after noting that the beam is level when the rider is at 0, see if when you put on the platform or pan 7½, 10½, 15½, 17½, 22½, 25, 27½, etc., units, the rider and the beam agree with what you are supposed to have on the platform or scale pan.

As regards the sensitiveness or delicateness (commonly called accuracy) of scales, that is quite another matter from correctness. The latter depends upon the correctness of measurement of the levers and graduations; the former, upon the delicacy of workmanship in making and fitting the parts, and in the selection and disposition of material. We have already alluded to the necessity for lightness and stiffness in the beams, and noted the effect upon the equilibrium of the position of the fulcrum or point of suspension. It is essential that the friction at these suspension points shall be reduced to a minimum, and that use shall not increase it. With this object in view, the knife edge is the most common mode of support or suspension, the edges and the loops or planes in or against which they play being of the hardest steel, and finished most accurately. In the finest balances (for chemical and physical research, assaying, etc.) the knife-edges play upon polished agate planes, and provision is made that there shall be contact between the edges and the planes only when weight is being determined. Bache made his knife-edges of a rectangular steel bar inserted in rectangular notches, so that in case any edge became damaged or dulled, another might be turned into action.

The spring is sometimes employed as a means of measuring weight. The discovery of Hooke, cautiously recorded in Latin through the medium of the monogram *ceiiinosssttu*, and afterwards announced more surely, *ut tensio sic vis*—"the force is as the tension"—applies very usefully in local weighing, a two-pound weight exerting double the tension and causing double elongation or compression of a spiral spring as that of a one-pound weight. The spring balance, however, has the demerit of being very apt to be strained by too long use or too great weight, and of not being adjustable. Further, it is only correct at the latitude and altitude for which it is graduated; as the earth's attraction diminishes as we leave the mean sea-level and as we approach the equator. A mass shown to weigh one pound on a delicate spring balance at the mean sea-level would, as we ascended a mountain or descended into a mine, or neared the equator, lessen its pull (or push) upon the spring, and appear to weigh less. With the balance or the steelyard, this diminution of the earth's attraction would affect the standard weight and the material to be weighed proportionately.

The torsion balance is a delicate device originating with Coulomb; by it the weight of a body is indicated by the amount of torsional deflection which it causes in a rod. It is open to the same objections as the spring balance.

The *hydrometer* or *aerometer* measures the comparative weight ("specific gravity") of liquids in which it is immersed, by our noting the depth to which the device sinks, or the weight required to make it sink to a given depth or mark.‡ It may be used to weigh or weigh out materials, by our noting the depth to which they will cause it to sink in a standard liquid.

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* The word *scale*, as originally applied to the pan of a balance, and afterwards extended to include the plural, the steelyard, and other weighing devices, has an entirely different derivation from the same word used to denote a series or gradation, or anything graduated—as a scale in music, a scale of miles, &c. The former is akin to *shell*, and implies a thin plate—A. S. *scealu, scalu*, a shell, parings, Dan. and Sw. *skal*, a shell, Dan. *skial, skal*, a fish-scale; hence, O. Fr. *escale, escaile*, N. Fr. *ecaile*, fish-scale, and *ecale*, shell of beans, eggs, nuts, &c.; It. *scaglia*. The latter implies a ladder or series of steps, and has its origin in the Latin *scalæ, scala*; It. *scala*, Sp. and Port. *escala*, Pr. *scala, escala*, O. Fr. *eschele, eschiele*, N. Fr. *echelle*.

† The term correctness must not be confounded with sensitiveness. A balance may be perfectly correct or true, and yet move so stiffly as not to be sensitive. We shall notice this point further on.

‡ This modification is Nicholson's.

The most important improvement in scale-making is doubtless the platform scale, permitting the weighing of large masses or loads of material, to be thrown or driven upon a surface flush with, or very little above, the floor, the weight being indicated upon a steelyard attached to a vertical pillar, either directly by or some distance from the platform.

The application of the compound lever, for the purpose of carrying the motion around the requisite corners, was invented in 1830 by Thaddeus Fairbanks, of St. Johnsbury, Vermont; and this marked departure in scale-making was the beginning of what is now the largest manufactory of scales in the world, employing over one thousand hands, and turning out sixty thousand scales per year, in one hundred and seventy-five styles and eight hundred modifications, arranged to suit the standard of all civilized nations and all special requirements of certain trade usages. The desiderata of a perfect platform scale may be summed up as accuracy, sensitiveness, strength, lightness, durability, freedom from friction, accessibility, freedom from lateral motion of platform within certain limits, adjustability without being liable to tampering, and convenience. A given load must register the same, no matter on what corner or position on the platform it is placed.

Selecting the scales of Messrs. Fairbanks & Co. as the type of the most improved practice, we would say that the platforms have hardened plates below, resting upon knife-edges carried upon levers, one of which levers has an A shape, and at the front end is suspended by knife-edges hung in hardened loops from the frame, as the back pulls upon the vertical rod attached to the steelyard. The other and U-shaped lever is hung by knife-edges in loops hanging from the frame at the back end, and its two ends, having eyes, are hung on knife-edges on the A-shaped lever. Thus each or any of the four corners of the platform registers perfectly, while the platform floats, as it were, in air, the knife-edges and loops permitting of easy motion in every direction, limited by check-rods. All motion is carried in straight lines, thus avoiding torsion and bending.

The adjusting poise at the back of the steelyard proper has adjustment not only horizontally, as affecting the balance, but vertically, to keep the points of suspension and the horizontal line of centre of gravity in their proper relations as the knife-edges wear.

Friction of the loops against the sides of the bars is prevented by having a wedge-shaped projection, either inserted or cast on, to bear against the loop side. The steel used in knife-edges and bearings is prepared by a process patented by themselves, giving toughness and hardness without brittleness. The Messrs. Fairbanks now hold twenty-two patents on scale-making, and are the originators of most of the important improvements and designs in their line. The magnitude and world-wide fame of their works, and the peculiar excellence of the product, may lead us to a description of the process of manufacture as by them carried on. G.

DRY STEAM.

The use of dry steam is not only a source of economy in the boiler, to prevent an unnecessary expenditure of heat, but still more so in the engine, where water contained in the steam not only does no work, but cools the metal in the steam cylinder, etc., thereby causing a fresh expenditure of steam to heat these parts up again. If with every pound of steam at 60 lbs. pressure a half pound of water is carried over, a quantity not unusual in a priming boiler, the latter has to be heated to the boiling point. If the feed water is introduced at 160°, 147 units have to be expended to bring each pound to 307°, or 73·5° for the half pound; the total heat of steam of 60 lbs. being 1209°, it requires 1209—160=1049 units to generate one pound of steam, hence $\frac{73.5\times100}{1049} = 7$ per cent. is expended in heating the water carried over.

The feed pump has of course 50 per cent. more work to do, and the heater wil have its efficiency reduced by one-third.

To avoid priming, a boiler should have a good circulation, and be large enough to do its work without forced firing; a good circulation will also improve the evaporative efficiency of a boiler, as the steam, (which is a bad conductor of heat) is quickly removed from the heated plates, and new water constantly follows it.

A steam trap, either fixed in a steam dome, or in some high place in the steam pipe, will drain the water trapped in it back to the boiler, thus saving heat expended in heating it; sometimes the steam pipe is extended downward from the throttle valve on the engine, so as to form a *cul de sac* for the accumulation of water, which can then be pumped back into the boiler.

A superheater, heated by the waste gases, may serve to evaporate the water carried over, and to dry the steam thoroughly; but if the priming is excessive, it will not be sufficient for this purpose.

If the water is carried into the cylinder, it will cool the metal, with which it comes into contact; the amount of this depends upon the surface exposed, the difference of initial and final temperature, the specific heat of the metal, the piston speed, the rate of expansion, etc., and the variable character of all these conditions makes it exceedingly difficult to give a figure for the loss thus incurred, but it is certainly considerable, and may range up to 30 per cent.

In non-expansive engines, this water is partly evaporated on the back stroke, abstracting heat from the cylinder increasing the back pressure, and in a condensing engine requiring more injection water and entailing more work upon the air pump.

In expansive engines, the re-evaporation of this water takes place already during expansion, whereby the final pressure is somewhat increased, but this is vastly overbalanced by a great fall in the initial pressure; for engines using 60 lbs. of steam, cutting off at ⅛ or ⅙, the initial pressure on the indicator card may often be found 20 to 30 lbs. below the boiler pressure.

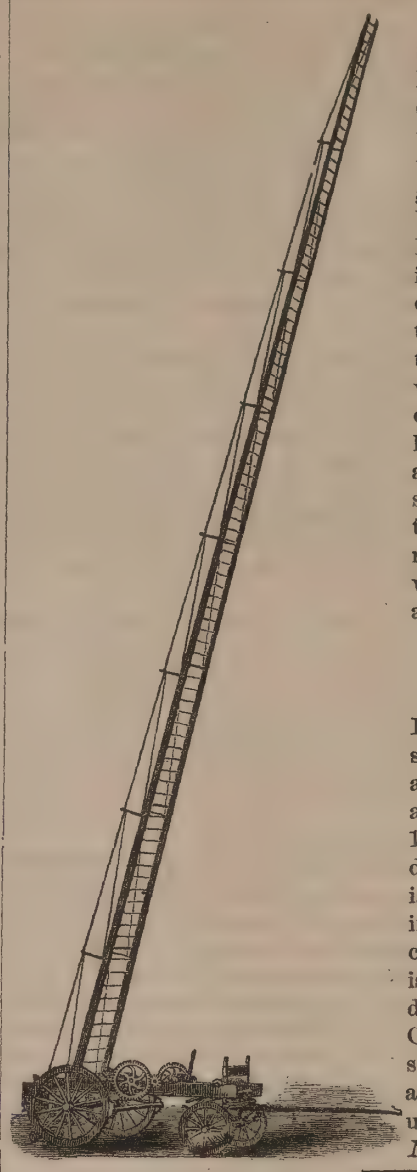
Even a steam jacket would be powerless against a great influx of water, as its surface and rate of conduction are necessarily limited.

Last, but not least, the danger of water in the cylinder must be considered, the result generally being broken pistons and rods, knocked out cylinder heads, and, as a natural consequence, a general smash up. J. Haug, M. E.

TECHNICAL INSTRUCTION.

The question of theoretical *vs.* practical training is by no means the most unimportant that comes before us; and the advocates of one or the other system point out admirably the disadvantages of each and the advantages of both. It seems to us an absurdity to attempt to lay down as a rule that one or the other of these systems shall be followed. The mechanic who cannot calculate the lap of a slide valve to produce a given cut off, and the student who can calculate the lap, but who does not know that the *D* valve has side bars at the ends of its exhaust port, are equally in the dark. The book learner who does not know that a cast steel bar shortens and one of wrought steel lengthens on being hardened, and that both increase in volume, is equally at fault with the shop learner who does not know that hardening is simply putting the particles in stress, and that the wrought bar on account of its lengthwise fibres permits of stretching most readily in length. Cornell University and one or two other technical institutions in this country provide for proper *mechanical* training, by providing professors who have both theoretical knowledge and practical experience, and having workshops in which the operations are performed and explained. Observing machinists at work, working at the bench and lathe, and hearing Prof. Sweet's explanations and "Ten Minute" talks* are of more use than either taking in Rankine, Weisbach and Holzapffel at school without practice, or serving the same time in a shop without knowing "why" and "wherefore." There is another means of instruction which would prove of value to those wishing general technical knowledge without wishing to learn any particular trade. We refer to a course of walks and talks through leading establishments; a competent instructor explaining both theory and practice to a limited number of learners. For example, under the head of "iron" might be described and shown the qualities of wrought iron, steel and pig iron, the modes of carbonization and decarbonization of unshaped masses (puddling, Bessemer and Siemens steel making); case hardening, and rendering malleable manufactured objects; "drop" and "hydraulic" die-forging, and shaping on the anvil by hand or power hammers; green-sand and chill casting; rail, plate and rod rolling and working; manufacture of tubing and boilers, rivets, bolts and nuts, saws and files; the operations of filing, turning, shaping, planing, milling, drilling, punching and shearing; abrading and polishing with grit-stones and emery wheels; tests of materials, etc. Such a course would embrace about eighteen one-hour visits to a dozen establishments, and not more than five or six should be taken at a time. We cannot conceive of a more pleasant and effective mode of imparting instruction. For other subjects and visits we might suggest stationary and locomotive engines, and wood and iron ship-building; wood, copper, steel, stone, zinc and photo-engraving; type making and setting; stereotyping and printing, as shown by visits to some of our daily papers having fast presses; the manufacture of carpets and calicoes, paper and wall-paper, leather and belting, and a score or more, all affording to the instructor opportunity to draw upon his fund of varied information and to impart it to his companions. Such peripatetic classes, where the student would feel not only at liberty but almost obliged, to ask questions on points not clear, or concerning other usage than that under inspection, would we are sure prove useful and popular, and might, under proper management, be made profitable. G.

*These pleasant and practical talks, under the head of "Ten Minute Papers," have appeared in the POLYTECHNIC REVIEW from time to time, and their publication will be continued.



THE PORTA LADDER (better known as the SCOTT-UDA) is the invention of an Italian named Porta, and was purchased by the husband of the energetic woman who now engineers its introduction. The cut shows it extended and in operation. The sections, of suitable length, are put together in a horizontal position by inserting in suitable rectangular sockets of iron, stout keys of wood. Each section is *trussed* by means of an upright iron strut at the base, and a diagonal tension chord extending from the top of this post to the top of the section. When the sections are put together, the tops of the struts are united by wrought iron chords extending from top to top of the posts, parallel with the ladders. A windlass then raises the whole structure to the proper angle, the side trusses giving stiffness and strength, while affording excellent hand-hold for the ladder-men. Suitable counterpoises aid in maintaining the centre of gravity within the wheel base. The ladders are wide enough to admit of two men passing each other thereon. G.

SOLVENT FOR SILK.—According to Julius Löwe, the following mixture forms a good menstruum for dissolving silk: 16 gm. cupric sulphate are dissolved in 140 to 160 gm. of distilled water, and 8 to 10 gm. of pure glycerine, of spec. grav. 1.240, are added, after which soda solution is dropped in, until the light-blue precipitate, which is formed at first, is again dissolved. The resulting liquid must be preserved, unfiltered, in a well-closed bottle, and when using it, the clear portion is poured off. This liquid dissolves silk without difficulty, forming a more or less viscous solution. On addition of hydrochloric acid, a white jelly separates. Wool, cotton and linen fibres are not attacked by this liquid, which may therefore be used to separate silk from other textile fabrics.—*New Remedies*, vi, 128.

The fifth periodical International Congress of the Medical Sciences takes place in Geneva on the 9th to the 15th of September.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

VI.

Problem III. An engine of 16″ stroke is required to cut off at 10″ and have a cushioning of 1½″. The largest port opening is required to amount to ⅞″ and the lead to ⅛″.

The crank-angles for cut off and for cushioning, the lead and the greatest port-opening are known, as indicated in the sketch Fig. 15, and the diagram can be drawn as follows:

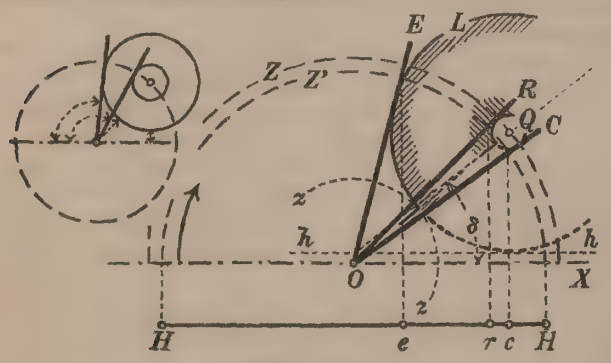

Fig. 15.

Sweep the crankpin-circle Z' to reduced scale, and under it the line HH for the stroke of the piston. Mark on it the points e and c for expansion and compression and find the corresponding crank-angles OE and OC. The lap circle must be tangent to OE; it must be ⅛″ above the line OX and must be ⅞″ from the centre O. Therefore we draw a horizontal line h ⅛″ above OX and a circle z, from O, with a radius of ⅞″. The required lap circle must touch the lines OE, h and the circle z, and its centre can be found by bisecting the angle formed by OE and h and finding by trial on this line a point Q from which the required lap circle can be drawn. The circle Z swept from O through Q forms the path of the eccentric. A circle from Q tangent to OC gives the inside lap circle, which in this case is found to represent negative lap, since the crank-angle for compression should be tangent to the dotted half of the circle. The necessary dimensions are found to be: travel of the valve 4¼″, outside lap 1¼″, inside lap, negative, ⅛″. The release takes place 2½″ before the end of the stroke.

Problem IV. The stroke of an engine is 21″ the travel of the valve 3½″, the outside lap is ¾″ and the inside lap = 0″. The width of the ports is ¾″ and the lead ⅛″. By this valve the cutting-off is effected at about 16½″ of the stroke. It is required to change the cut-off to 14″ of the stroke by changing the throw of the eccentric, leaving the lead angle the same as it was before.

We first draw the diagram for the original travel of 3½″ (Fig. 16) to obtain the lead angle AOX. Next we construct

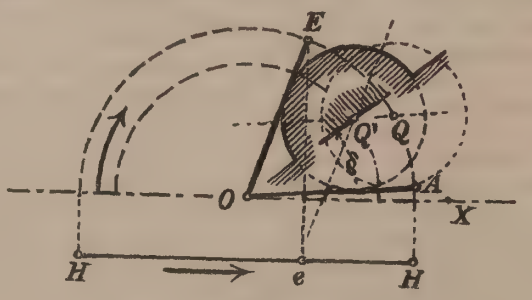

Fig. 16.

the crank-angle OE for the cutting-off at 14″. Knowing now that the lap circle of the new diagram, the radius of which is to be ¾″, must touch both the lines OA and OE, we draw two lines at a distance of ¾″ from, and parallel to, these two lines, and the point of their intersection, Q', is the new centre of the lap circle. Its distance from O is the required throw of the eccentric, which is 1⅜″. The greatest port opening for admission will be ⅝″ which is ⅛″ short of the width of the port. The angle of advance, the degree of cushioning and the point of release can subsequently be found from the diagram in the usual way.

THE SCOPE OF THE COMMON SLIDE VALVE.

The most primitive form of the slide valve is that without any lap, lead or angular advance, by the operation of which the piston will be exposed to the full steam-pressure on one side, and to exhaust on the other, for the entire duration of the stroke. But the instant the crank passes the centre, the conditions are suddenly reversed and that end of the cylinder which was just being filled with steam is now brought in communication with the exhaust passage. It is evident that all the steam filling the cylinder cannot instantly escape through the opening which at first is very small, and a considerable back-pressure during the first part of the stroke will result. Besides, the expansive power of the steam is not utilized at all, but is prodigally wasted. To obviate these losses lap must be given to the valve and the eccentric must be advanced. But the common slide valve should, under ordinary conditions, never be used to close the ports before half stroke, for a reason that will at once be seen if we examine the operation of a valve with earlier cut-off. Suppose it was required to construct a valve with 4″ travel, to cut-off at ¼ of the stroke, with no lead. We draw the circle Z (Fig. 17), determine the crank-angle OE for ¼ of the stroke, and

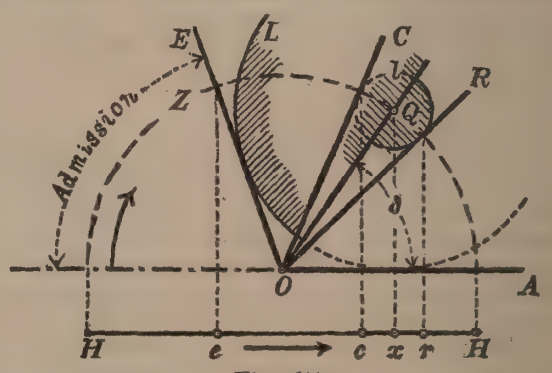

Fig. 17.

bisect the arc EA to obtain the centre Q of the lap-circles. The outside-lap circle can now be drawn at once. Supposing the valve to be without inside lap, the cushioning on the one and the release on the other side of the piston will begin when the crank passes the line OQ. Regarding the line HH' as representing the stroke of the piston we find that compression and release begin at x; the expansion, from e to x, is curtailed by an early exhaust, and the compression from x to H is excessive. If we endeavor to delay the exhaust by giving inside lap, in order to prolong the expansive action of the steam, we find, by drawing the lap circle l and the crank-angles OC and OR, that the amount of cushioning will be increased. On the other hand, if we try to diminish the degree of compression it will be necessary to apply negative inside lap, which may again be represented by the circle l. The cushioning will then commence at OR; but it will be noticed that this measure will hasten the release which then takes place at OC. We see from this that with no inside lap, both the release and the cushioning begin much sooner than desirable, and that any change for the sake of delaying the one causes a hastening of the other.

Another very disadvantageous point will be noticed. The greatest port-opening indicated by this diagram is but little more than $\frac{1}{10}$ of the travel of the valve. Hence it is clear that a plain slide valve so proportioned as to cut off at ¼ of the stroke produces but a small opening for the admission of the steam.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

[☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*]

ENGINEERING—CIVIL, MECHANICAL &c.

The Whitehead Torpedo.—The British Government manufactures its own Whitehead torpedoes, having paid several thousand pounds for the privilege. The machinery inside this torpedo is still a secret, which is strictly maintained by our Government, but the principle of the invention is well-known. It is a long, cigar-shaped machine measuring a dozen feet and upward. In the head is a charge of some violent explosive, such as gun-cotton, or dynamite, which explodes as soon as the torpedo strikes an obstacle. The motive power is compressed air, which is forced into the machine by powerful air-pumps, immediately before the torpedo is discharged into the sea, no less than 600 pounds on the square inch being the pressure exerted. The Whitehead is shot from a tube, and moves through the water as straight as a dart, the compressed air working upon a screw in the tail of the machine. The delicate machinery permits the torpedo to swim at any depth below the surface that may be desirable, and it flies straight in the direction it is aimed, at a speed of something like twenty miles an hour. If it fails to strike the foe, then the intelligent apparatus at once rises to the surface, becoming innocuous as it does so, and may in this condition be captured without difficulty.

A torpedo of this sort striking the sides of an iron-clad would almost infallibly send her to the bottom, and although it has been proved that a network or crinoline around the ship is capable of retarding the progress of a "fish" of this nature, and exploding the same harmlessly in its toils, it is obviously a very difficult matter thus to protect one's craft. Against heavy torpedoes, indeed, there seems no way of defense at all (the Whitehead generally carries a charge of seventy or eighty pounds, but moored torpedoes may contain a 500-pound charge), and therefore Turkish vessels will have to give Russian ports a wide berth. All must remember how the magnificent fleet of the French was kept at bay by the torpedoes of the Germans in the North Sea in 1870, and the Black Sea ports are no doubt similarly protected. So demoralizing is the dread of the torpedo with sailors apparently, that they will dare anything rather than venture into waters which conceal these cruel foes.—*From "Science and War," in Popular Science Monthly for September.*

The Hudson River Tunnel.—It is the intention of the Tunnel Company to begin work early in the coming fall. A shaft twenty-eight feet deep has been dug at the foot of Fifteenth street, Jersey City, and this depth will be increased twenty feet. From this as a starting point, the tunnel will proceed in a northeasterly direction under the Hudson River and the Christopher street ferry slip. The entrance on the New York side will be in the neighborhood of Washington square. From Jersey City the grade will descend two feet in every hundred feet, until a point 2,700 feet from the New York side is reached, when it will begin to ascend at the rate of one foot in every hundred feet. The tunnel will be two miles in length, with a road-bed twenty-three feet wide, and two separate tracks. Through its entire length it will be lighted by gas. The wall be constructed of brick, with a thickness of four feet. At no point will the top of the tunnel be less than thirty-five feet below the surface of the water, and in many places it will be seventy feet below. One hundred and twenty laborers will be engaged in the construction of the tunnel. The work will go on during the whole of the twenty-four hours, the force working in three relays, for eight hours each. Although the tunnel will be used for the conveyance of passengers, its main object will be the transportation of freight to and form the great railroad lines which terminate in Jersey City. The capital of the company is $10,000,000.—*Iron Age*, August 16, 1877.

Progress of the St. Gothard Tunnel.—During week before last the work on the St. Gothard tunnel advanced 30.5 meters on the Goeschenen side and 4.5 metres on the Airolo side, in all 35 metres.—*Moniteur Industriel Belge*, iv, 339.

A Berlin Tramway.—A city railroad is now under construction in Berlin. It is to extend from the Lower Silesian terminus to Charlottenburg, and will be seven miles long. It is expected to cost over £220,000 per mile, and as half the right of way and grounds are already acquired and the work has been in progress a year, the estimate should not be very far out of the way. The road is to have four tracks, two for the through traffic of the roads with which it connects, which are six in number. Each of these lines is to have three stations in the city. The other two tracks will serve exclusively for local traffic, and will have six stations at intervals varying from less than half a mile to two and a quarter miles, and probably two other stopping places will be provided.—*Iron*, x, 132.

Reflecting Sights, enabling the gunners in turrets to lay their heavy guns without exposing themselves to the enemy's fires, were demanded some time since, and were manufactured on an ingenious plan in the Royal Gun Factories. They have now been rejected by the Royal Navy, who find that they are likely to prove inconvenient, if not altogether useless, in time of action, when the officer or seaman who points the gun would probably prefer to do so in the ordinary way, even at some risk, rather than trust to an artificial appliance under cover, but most likely to be obscured by smoke and dust.—*The Engineer*, xliv, 89.

MINING, METALLURGY AND MINERALOGY.

The Total Shipment of Iron Ore from the Lake Superior iron district the present year, up to July 11, was 415,483 tons, against 274,782 tons for the corresponding period in 1876—an increase of 140,701 gross tons. This would seem to indicate a much larger product of iron this year than last, notwithstanding the dullness that characterizes that industry. —*Western Manuf.*

A Curious Invention.—The *Stock Report* of San Francisco speaks of a new invention lately patented on the Coast, which is intended to supplant the now costly assayer, and drive that arrogant individual into some other and less remunerative business. We have heard from another source that the patentee was a few years ago engaged in mining, and in the pursuit of that occupation paid out a good many hundred dollars to the local assayer, who kept alternately encouraging and discouraging him by good and bad assays, until, in disgust, he threw up his mine, abandoned the district, and, vowing vengeance on the whole tribe of analytical chemists, made an oath to spend the balance of his life in seeking for a means to undermine their business. This he now professes to have done. The new machine is provided with a compass, clinometer, horizontal arc, level, and telescope These are for the ordinary operations of underground surveying. Inside is the more complicated assaying mechanism. The machine, says the *Stock Report*, on being placed against a piece of ore, will immediately indicate the coin value per ton. Laying it against a stope, the solid contents and average assay are instantly registered, and, by moving it around into different parts of the mine, the cubical contents of the vein and the value per fathom are immediately and infallably indicated. But these are only a few of the virtues of the wonderful machine. It will foretell stock speculations, prophesy of assessments, tell tales on defaulting cashiers and treasurers, trip up cunning superintendents, and perform a vast number of odd and serviceable jobs, hitherto accomplished only by the tedious and circuitous methods of science, or through the equally uncertain pathways of the law. According to our Coast exchange, these invaluable machines are now for sale at the excessively low price of $125,000 each, or by the dozen $1,400,000.—*Eng. and Min. Jour.*, xxiv, 126.

Value of Nickel Ore.—The *Eng. and Min. Journal* replies as follows to the question, "What is the present market value of nickel ore per unit contained in the ore?"

The only large dealer in nickel in this country is Mr. Joseph Wharton, whose mines are in Lancaster County, Pa., and we are indebted to his courtesy for the following interesting information regarding the present condition of the nickel trade:

"No satisfactory answer can be given to this question. Just now it has no value, for pure nickel has but a nominal value, and is unsalable, except in trifling quantities at about $1.70 currency per pound, which is but little over one-half of last year's price.

The entire consumption of nickel in America being in good years but about 100,000 pounds per annum, and this year probably not over 40,000 pounds, it is clear that the delusive notions which have become prevalent that one has only to discover a nickel deposit to realize a speedy fortune can only lead to disappointment.

At best, and even if a large market existed, nickel ore could only have value when existing in large quantity of good quality, and near to fuel, fluxes and market. Should any really great deposit be found, the price would fall, as has in fact been the result from the New Caledonia discoveries.

The mine in Lancaster County, Pa., can produce with perfect ease double as much nickel as this country consumes, and it has all the advantages above named. It has, however, been found necessary to dismiss two-thirds of the miners there, and the mines may possibly have to be closed entirely for want of a market."

Silver Mud in Oregon.—In Wasco County, Oregon, there is a flat, thickly studded with springs of a peculiar character, that throw out mud which has overflowed a considerable area. Some months ago it was reported that this mud had been discovered to be argentiferous and very rich, some specimens assaying over $2,000 to the ton. An effort was made to organize a company in this city to work the mud springs, but the enterprise collapsed in consequence of a suspicion raised that the mud had been "salted," and the memorable Arizona diamond field swindle was too fresh in the recollection for the successful prosecution of another fraud in the same line.

Professor Thomas Price analyzed samples submitted, and reported that he had discovered unmistakable evidence of "salting," the microscope showing filings, crystals, and free gold, which he had no hesitation in declaring had been mixed in with the mud with the manifest design of instituting a great swindle.

Professor H. G. Hanks also examined specimens, but while he was inclined to suspect fraud, he was unable to determine positively whether the argentiferous mud was an artificial or natural production. Professor Hanks now intimates that the flow of the Oregon mud springs is in reality heavily impregnated with silver, and this result he announced in a paper read before the California State Geological Society on June 5, 1877.

The existence of springs yielding soft mud, charged with free silver, says Professor Hanks, is new to science; and scientific men, both here and at the East, who examined specimens, pronounced them fictitious without hesitation. The specimens latterly examined by Professor Hanks, he says, were very rich, and silver was discovered in a free state. By simple washing the silver could be wholly separated, and when then examined the microscope failed to reveal the source of the precious metal. Had it been filings a single glance would have sufficed to detect the fact. Had the silver been precipitated from solution by copper it would have been crystallized.

An amalgam of silver and mercury would have yielded a sublimate if strongly heated in a glass tube closed at one end. Such an amalgam introduced into the wet mud, and the whole heated sufficiently to have volatilized the mercury, would have left the substance in a hard, baked state, which could not again have been reduced to the state in which it reached this city. From these conclusions, if the silver had been introduced for fraudulent purposes, the substance was very remarkable, from the fact that some process had been employed not easily understood.

Professor Hanks finally obtained the address of a gentleman represented to him as being of unquestioned character, Richard Hurley, residing in the vicinity of the wonderful springs in Wasco County, and applied to him for information. In reply to Professor Hanks, Mr. Hurley writes:

"There is no mistake as to this mud containing silver. I have assayed over 100 samples which contained silver, some as high as $2,300 to the ton. The samples I obtained from the springs myself. I think the weather has considerable to do with the mud containing silver. I obtain the best results when the weather is warm. Sometimes in one of the larger springs, when the weather is cold, the mud will be of a yellow color, showing no silver; but when the day is warm the mud is blackish-blue, at least in places, and rich in silver. They seem to work more actively in a warm afternoon. Some of them contain a great deal of acid, the bones of animals that fall into them being dissolved in a few months. There are old wells which assay from $5 to $1,200 to the ton.

"One assay I made from the flat, half a mile from any spring, assayed $1,200 to the ton. There is a great deal of salt, almost pure, all over the spring flat. There are between 100 and 200 quartz leads discovered, running in two directions close to the spring. I find silver in several of them, all the way from a few dollars to $100 to the ton. Some of these leads run through the springs—at least, they point in that direction. The altitude of this place is between 4,000 and 5,000 feet."

Professor Hanks also refers in his paper to the recent discovery of a peculiar silver-bearing deposit located in Southwestern Utah. It occurs in the Maud Mine, six miles from Leeds. Some assays as high as $700 per ton have been made. Instead of being sandstone, as supposed, Professor Hanks

found the deposit to be sedimentary, but closely resembling the Oregon mud. Under the microscope it has all the appearance of that strange substance. The Oregon mud, if allowed to dry in large quantities, would soon form a similar substance to the Utah mineral, in appearance at least. The silver is in the state of chloride, and is seen under the microscope both amorphous and in crystals. An analysis of the two minerals will be interesting, and may throw some new light on the subject.—*San Francisco Examiner.*

The Great Coal Fields of Ohio. -A district of one hundred miles square, including the counties of Athens, Perry, and Hocking, is the future coal field of this nation. It is to be the "Black Country" of the United States, as the noted district in Staffordshire is the "Black Country" of Great Britain. In fifty years it will probably equal Staffordshire or any district in the world. This district has twenty-two feet of solid coal in five seams. The great vein (properly "bed") is in places twelve feet thick, and nowhere less than six feet. Mingled among the coal beds are inexhaustible beds of iron. The thickest is five feet deep at the outcrop; the thinnest, in places, sinks to six inches. But the thickness of neither seam is quite persistent; there are "waves" from time to time, which narrow the seam. The coal, on the contrary, may be said to run from hill to hill with perfect uniformity. Limestone is also present in any desired quantity. —*Nelsonville (O.) Gazette.*

Prof. Thurston on our Domestic Metals.—The statement is made by Prof. Robert H. Thurston that this country has for years been importing cast iron, while domes tic products of equal and even greater intrinsic value sell at lower price. Other similar instances of unwisdom are cited by Prof. Thurston, as, for example, the fact that we are importing boiler-plate at eleven cents a pound, when we can purchase American steel, vastly superior in all respects for the special purposes to which the former article is applied, at eight cents. Again, we import vast quantities of foreign steel tools, when at Pittsburg and elsewhere we make steel fully its equal. In New England and Pennsylvania we have ores from which is made the finest cast-iron ordnance in the world. In Ohio we make a metal for car-wheels such as is never seen in Europe, and of such tenacity and elasticity that foreign engineers listen incredulously when it is described. Our Lake Champlain ores make an iron fully equal to Swedish for conversion into steel; and around Lake Superior and in Missouri we have deposits from which comes Bessemer metal far superior to the phosphorus-charged metal we import. New Jersey supplies us with zinc which meets with no competition as a pure metal, and which can be used without purification even for chemical purposes; and our native copper is absolutely free from admixture with injurious elements. It is time that these facts should be known, and that the people should disabuse their minds of the idea that, because a commodity is "imported," it is therefore of greater intrinsic value than a domestic product.—*Pop. Sci. Monthly, Sept.*

Rare Minerals in Colorado.—Writing of rare minerals found in Colorado, Mr. T. F. Van Wagenen, in the *Engineering and Mining Journal*, says that thallium, indium, and cadmium, have lately been detected in ores from that State. Of the rarer metals there have been found in Colorado, besides the three mentioned above, nickel, cobalt, selenium, tellurium, uranium, bismuth, molybdenum, and platinum, and there is scarcely a doubt that columbium, thorium, titanium, and vanadium, will be recognized as soon as proper search is made. A belt of tellureted veins is believed to traverse the entire State from north to south. Two years ago, sylvanite and altaite were found in San Juan county. The principal locality for bismuth ores is in Geneva, where two mines are being worked that carry a considerable quantity of schirmerite. Sulphide and carbonate of bismuth occur on Sugar-loaf Mountain, Boulder county. Nuggets of native bismuth are common in the upper gulches of the Blue Valley; the same metal has been found also in the Arkansas Valley. Nickel ore, ranging from two to five per cent., has been found in three localities. Among the mineralogical curiosities of the tellurium belt may be mentioned a telluride of mercury found in the Mountain Lion mine. Native mercury and amalgams of both gold and silver have also been found at several points along this belt.—*Pop. Sci. Monthly, Sept.*

Blast Furnaces in the United States.—A statement compiled by the *Iron Age*, reports that there are 704 blast furnaces in the United States, of which 270 burn charcoal, 208 bituminous coal or coke and 226 anthracite coal. Of these, 87 charcoal, 85 soft coal and 87 anthracite furnaces, 259 in all, are in blast, leaving 445 idle.

—Coal was first used for fuel in England about 1234, although it did not come into general use there until 1725. In this country it was first mined and used in Pennsylvania in 1806. Gas was first evolved from coal by Dr. Clayton in 1739. The first display of gas lights from coal was made in Birmingham in 1802.—*Manuf. & Merch. Adv.*

Heat Underground.—Some of the drifts on the lower levels of several of the Comstock mines are found to be so hot that it is next to impossible for the men to work in them. When they can work it is to great disadvantage, and considerable labor and money is expended by the companies to supply fresh air. In some cases, men can only work a few minutes and then run out to cool off. In the Consolidated Virginia mine, the face of the north drift on the 1750 foot level from the Gould & Curry, near the east wall of the ore vein, is so hot that it is necessary to keep a close, tight box, or cooling room, in close proximity to the workmen, in which the temperature of the air is kept down by compressed air, so that the men may cool off and change every few minutes. Another of these cooling boxes has to be placed at a half-way point in the drift for the use of the men who run the cars in and out.

The Savage incline, also, at a point near the water, is so hot as to be almost beyond human endurance. But for their shirts the skin of the men would be blistered as though by a jet of scalding steam. A man from the mine showed an *Enterprise* reporter a blister on his arm that was nearly as large as a man's hand. This blister was caused by exposing his arm at the bottom of the incline. It is so hot down at the water that in screwing a nut on the end of a bolt one man would be able to do no more than fasten a monkey wrench upon it before he would have to retreat. Another would then descend and give the wrench two or three turns. One day last week the giraffe got off the track well down the incline, and in trying to replace it one of a small party of men was so overcome by the heat that he fell down in a state of insensibility. His companions carried him from a point between the 1700 and the 1900-foot levels to the 1300 foot level of the Hale and Norcross mine, where he could obtain a mouthful of fresh air. He was still unconscious when he reached the point named. The Hale and Norcross mine is now quite cool, the draft in it having again changed, being once more down the main shaft.—*Mining and Scientific Press*, xxxv, 88.

Australian Cannel Coal.—A discovery has been made in Australia, which confirms with singular minuteness the theory that assigns to Cannel coal an origin from leaves. It is difficult to understand how leaves can accumulate free from dirt in sufficient quantity, to form the beds of Cannel coal, now several feet thick, and representing many times their mass in leaves. But in Australia, just such a mass of leaves has been found partially, but not completely altered to Cannel. The appearance and fracture of fresh blocks, are the same as of this kind of coal found elsewhere, but after some years' exposure it can be separated with a knife into thin laminæ, which shows that the mass is composed principally of leaves. The bed is six feet thick, and the government geologist calls it "incipient lignite.—*Savards' Coal Trade Journal*, xiv, 73.

Coal in Utah.—A number of English gentlemen have gone to San Pete, to examine the coal fields of that valley, and the practicability of a railroad from there to market. We understand that there is talk also of the Central Pacific Railroad Company purchasing some of these claims, with a view of putting down a road from Ogden to San Pete valley.—*Salt Lake Tribune.*

A New Mercury Ore in Mexico.—At the last meeting of the New York Academy of Sciences, Mr. F. Kurz called the attention of the society to a new mercury ore from Mexico, which upon analysis was found to contain sulphur, selenium, mercury, zinc, cadmium, and iron. It is a species of cinnabar remarkable for containing selenium to the extent of 18 per cent. in its composition, and was called *guadalcazarsite*, from the location in which it was discovered. It is found in considerable masses and could be treated like the ores of mercury.—*Le Technologiste*, 1877–72.

—The *Railroad Gazette* has information of the laying of track on new railroads as follows:

MENOMINEE RIVER.—The first track is laid from Spaulding, Mich., west to the Breen Mine, 12 miles.

This makes a total of 842 miles of new railroad completed in the United States in 1877, against 1,142 miles reported for the corresponding period in 1876, 594 in 1875, 913 in 1874, 1,966 in 1873 and 3,372 in 1872.

—The Mars mine, on Lake Superior, recently produced a mass of copper weighing nine tons.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Observations of Mars.—In the observations about to be made of Mars at the time of its opposition, which occurs in September, Mr. Proctor thinks that it will be a favorable opportunity for a more careful study of the varieties of light and shade and of color in this planet. In comparing pictures of the same object made by different observers, great difference is apparent, and can be traced to this cause. The notion that the surface is divided into ruddy and green portions, and the white polar crown cape and occasional white cloud markings, is far from the truth.

A New Method of Preserving the Bodies of the Dead has just been exhibited in Berlin. It is the invention of a Mr. Tominetti of Hamburg, and consists in a thorough drying of the tissues by means of an injected gas, which absorbs the moisture and drives it out through the pores. Prepared in this way, an animal preserves its form and color in perfection. Mr. Tominetti exhibited a bear which had thus been treated after his death four months previously. Slices were cut from the body to show that the tissues were not destroyed but, except for their desiccation, were preserved in excellent condition.—*Sci. Am.*, xxxvii, 105.

Lace Paper.—The manufacture of what is called lace papers is an important branch of trade in Germany, and even in these times of general depression has maintained its activity. The uses of these papers are exceedingly various; it is the general custom in Germany to decorate ceilings, fireplaces and the like with them, while confectioneries, bouquets, etc., are put up in gay-colored wrappers.

The great difficulty in manufacturing these papers is to produce a surface which will exhibit, as in real lace, the fine gradations of lines. Small lead hammers are used for punching on stamps. The holes and edges of the desired pattern are raised on the stamp, and the paper being laid on it is hammered until the hollow surfaces project on the other side.

The paper must be uniform in strength and sizing, and also in color, or it will appear as if composed of different kinds. As it frequently happens that the edges of the sheets are not equally pressed, care is taken to avoid any folds or creases in the middle. From two to four sheets are stamped at a time, and unless they have been rubbed with talc they must be closely pressed together. Some manufacturers have the stamping done in penal institutions, but the advantages of this, if any, are not very apparent. The appearance of the paper is very much improved when the sheets are pressed, the impression being much clearer, but for most purposes this is not usual. For bouquets card paper must be used, and the centre replaced by pasting a piece of glazed card so as to form the funnel, but previously a cross must be cut out of the centre so as to admit the stem of the bouquet. Some of these bouquet-holders have from twelve to twenty-four plys, and are made in imitation of ferns, etc. There are some fifty manufacturers of these *papiers de luxe* in Berlin, and they are now introducing them for various ornamental purposes—as borders to chromo-lithographs, etc., and bringing them out in colors. —*Paper Trade Journal.*

Boiling Water in a Sieve.—This curious experiment, lately devised in France, is performed in the following manner: If the open mouth of a glass bell-jar of any diameter from 20 to 50 centimetres be closed by means of a piece of coarse muslin, and then depressed into a vessel of water, the water may be drawn up into the bell-jar by aspiration through a tube passing through the upper portion of it. The bell-jar on being now raised out of the water is found to retain its contents, the muslin meshes thus performing the function of capillary tubes. At each of the meshes there is a well-marked meniscus. Capillary phenomena are largely modified by changes of temperature; nevertheless, a Bunsen's flame may be placed under the suspended water, and its temperature raised even to boiling without any of its escaping through the meshes. It will fall, however, if the ebullition be too violent. —*Boston Journal of Chemistry*, xii, 15.

The Moons of Mars.—The following despatch from Washington has an interest that is not merely scientific:—

"The great telescope of the Naval Observatory has just signalized itself, in the hands of Professor Hall, by one of the most remarkable additions to modern astronomy—nothing less, in fact, than the discovery of one satellite, and probably two, to the planet Mars. About 11 o'clock on Thursday night, Professor Hall noticed a very small star following Mars a few seconds, and made an estimate of its distance from the planet. Two hours later he looked again, and was surprised to find that the star seemed to be still following the planet. As the distance had not increased, while the planet was moving away at the rate of fifteen seconds an hour, he therefore made a careful series of measures, which showed that the satellite was eighty seconds from the planet. An hour later it was still there, but Mr. Hall made no further observation, hardly crediting the great discovery he had made.

"On Friday morning he showed his observations to Professor Newcomb, who was so confident that the object must be a satellite, that he calculated roughly the time of its revolution, which he fixed at one day eight hours, or a little less. This showed that the object would pass behind the planet some time during the following night, and that if not seen in early evening, it would reappear before daylight in the morning. In the evening it was invisible, but reappeared, true to the prediction, about 1 o'clock in the morning with a companion satellite. Professor Hall had now so little doubt of the reality of the object that he made the discovery known to Admiral Rogers, the Superintendent. It was still thought

best to wait for another look before formally announcing the discovery, especially as Professor Newcomb's calculation showed that it would be on the opposite side of the planet on Saturday evening. Hardly was the telescope turned on Mars when the satellite was seen and its position determined by several of the astronomers. In the course of the evening an object, which might be another satellite, much closer to the planet, was found by Mr. Todd, but nothing could be determined respecting the time of its revolution. The observations of the first satellite showed its time of revolution to be about thirty hours, but several weeks' observation will be required to settle this exactly.

"Scientific authorities here regard this as ranking among the greatest telescopic discoveries of the century; the only two which exceed it being that of the asteroid group in 1801, and of the planet Neptune in 1846. Professor Hall, the fortunate discoverer of the satellite, has been attached to the observatory since 1862. When Professor Newcomb resigned the charge of the great telescope, in 1875, he succeeded to it. He is an able and learned mathematician, and an unostentatious and conscientious observer. Professor Newcomb telegraphed the discovery of the satellite this morning to the European observatories, and it is hoped that the weather there will permit of further observations. Professor Hall, who has kept continuous watch at the instrument for a week, and who was fortunate enough to make this remarkable discovery, furnishes the following statement:

"'The first satellite of Mars was discovered at the Naval Observatory, in Washington, on the night of August 16. It was first seen at forty two minutes past 11. It has been observed on the nights of the 16th, 17th and 18th of August. The time of the revolution of this satellite about Mars is about thirty hours. Its greatest apparent distance from the centre of Mars is eighty seconds of arc. I think I saw another satellite on Saturday morning about 4 o'clock, but of the existence of this second satellite I am not absolutely certain. I believe, however, that there are two, and I expect to be able to determine this to-night, as I commence observations again about midnight. The satellite in its appearance is a faint object of about the size of a star of the thirteenth or fourteenth magnitude, and it was possible to discover it only by putting Mars, which is now exceedingly bright, out of the field of the telescope, so as to get rid of the brilliant light of that planet.'

"distance of the first satellite from the planet is between 14,000 and 15,000 miles, which is less than that of any other known satellite from its primary, and only about one-sixteenth the distance of the moon from the earth. The inner one, as to the existence of which the astrologers are not yet absolutely certain, is still closer. The diameter of the new satellite is very small, probably not more than 50 or 100 miles.

"The following despatch announces officially the discovery of the satellites:

"'WASHINGTON, Aug. 19.—Two satellites of Mars have been discovered by Hall at Washington. First, elongation west, August 18, eleven hours. Washington time. Distance, eighty seconds; period thirty hours. Distance of second, fifty seconds. JOSEPH HENRY.'"

The official report of Rear Admiral John Rodgers, superintendent of the Naval Observatory, in this city, in regard to the recent discovery of the satellites of Mars, was received at the Navy Department this morning. He says that from the observations made by Prof. Asaph Hall, of the Observatory, with the twenty-six inch refractor, the planet Mars has been found to have at least two satellites. Professor Hall finds on examining his observing book that the satellite which was first discovered, and which he supposed was seen for the first time August 16, at 11 : 42, had been, in fact, observed August 11, at 14 hours 40 minutes, but as he had no opportunity at that date to wait for the planet's motions he failed to recognize the object as a satellite. It was, however, recognized and observed as such on August 16, and has been observed on the 17th, 18th and 19th of August. This satellite has an apparent distance from the centre of Mars of 82 seconds, and its time of revolution around the planet is 30 hours. Its magnitude Prof. Hall estimates as the 13th or 14th. The plane of its orbit has now a considerable inclination to the line of sight from the earth to Mars. At its elongations its angles of position are 72 degrees and 252 degrees. The second satellite was discovered August 17, at 16 hours. It appears to be quite as bright as the first one, and at its elongations has nearly the same angles of position, which correspond to the equator of Mars. Its apparent distance at the elongations and its periodic time are not yet known. The following are the preliminary elements of the outer satellite as calculated by Prof. Simon Newcomb: Major axis of orb, 82 seconds; angle of major axis, 70 degrees and 250 degrees; minor axis, 28 seconds; passage of satellite through western apsis, August 19, 16 hours 40 minutes. The period of the inner satellite or satellites is so short, probably less than eight hours, that it cannot be fixed.

MISCELLANEOUS.

Average Statures of Men.—The *Druggists' Circular*, in noticing the questionable statement "that we are becoming a degenerate race," discusses the tables prepared by Dr. Baxter from the records of the Provost Marshal General's Bureau made during the civil war. Previously no question has been debated and none left in a less satisfactory condition than that of the mean stature of the full grown man. These tables are gleaned from actual measurements taken by surgeons sworn to do their duty. and furnished with needful aids and appliances. The measurements of the rejected as well as the accepted men are used; so that they fairly represent the whole portion of the country. These examinations were made during the latter part of the war, after the finest fighting material had been enlisted, consequently these statistics do not overestimate the average development of the American people. From the tables of Dr. Baxter and those of Mr. Gould, gathered by the Sanitary Commission, the Indians are shown to be a tall race. In the comparison of States the Indians would rank as the ninth, though it is curious to see that they head the list of nationalities.

Here follows the table showing the superiority in stature of 501,068 men of the various nationalities,—185,448 foreigners, $\frac{3}{5}$ of whom were from Germany and Ireland—the former having a few thousand more than the latter:

	Nation.	Mean hight in inches.		Nation.	Mean hight in inches.
1	U. States, Indians	67.934	14	Wales	66.418
2	U. States, Whites	67.672	15	Russia	66.393
3	Norway	67.467	16	Switzerland	66.381
4	Scotland	67.066	17	West Indies	66 307
5	British America	67.014	18	France	66.277
6	Sweden	66.896	19	Poland	66.211
7	Ireland	66.741	20	Mexico	66.110
8	Denmark	66.648	21	Italy	66.000
9	Holland	66.637	22	South America	65.899
10	Hungary	66.584	23	Spain	65.635
11	England	66.577	24	Portugal	65.432
12	Germany	66.536			
13	U. States, Colored	66.531		Mean of total	67.300

From an examination of the United States Army Statistics for sixteen years—1839 to 1855—the mean stature of recruits from Georgia, Tennessee, North Carolina, South Carolina, Alabama and Virginia, ranged between 68.272 inches to 67.488 inches. The average obtained from these facts is 67.357 inches, about one-third of an inch less than that (67.672 inches) derived for the Northern States; while that obtained by Mr. Gould was smaller by about one-hundredth of an inch. The close correspondence of the three sets of observations is an indication of the accuracy of the whole. Altogether they are the results of measurements of nearly 1,500,000 American born white men, with a mean stature of 67.646 inches. In point of stature the American people is entitled to the first rank among the nations. One-third of the native born white Americans were dark-complexioned, with stature one-tenth of an inch above the fair-complexioned; the reverse of this was noticeable among the natives of British America, England, Ireland and Germany, where the fair-complexioned exceeded the dark-complexioned in about the same proportion.

Graded according to the mean stature of the inhabitants (American born whites), the different Northern States stand as follows:

	State.	Mean hight in inches.		State.	Mean hight in inches.
1	Kentucky	68.677	14	Maryland	67.814
2	Kansas	68.551	15	Ohio	67.782
3	Minnesota	68.371	16	Vermont	67.583
4	Missouri	68.337	17	Delaware	67.490
5	California	68.307	18	Pennsylvania	67.470
6	Nevada	68.286	19	District of Columbia	67.353
7	Indiana	68.080	20	Rhode Island	67.290
8	West Virginia	68.005	21	New York	67.274
9	Wisconsin	67.911	22	New Jersey	67.023
10	Maine	67.895	23	New Hampshire	66.929
11	Iowa	67.895	24	Massachusetts	66.891
12	Illinois	67.835	25	Connecticut	66.587
13	Michigan	67.826			
				Mean of total	67.672

The Mackenzie & Sayre Manufacturing Company, 141 Broadway, is about to introduce a new process and apparatus for the production of heating gas for metallurgical purposes, when an intense heat is required, such as the smelting of iron, copper, lead and silver ores, the melting and refining of iron and other metals. We shall shortly publish a description of this apparatus, for which several important advantages are claimed, the most prominent of which are stated to be economy of fuel, saving of labor, and dispensing with blowing machinery.

—A serviceable lifter and changer of heavy weights is spoken of by *Engineering*, in the form of a locomotive crane. There are about a dozen of them in use in Europe. —— A pneumatic clock, says the *Engineer*, invented by H. I. A. C. Mayrhofer, has been tested satisfactorily in Vienna for about four months; it is now connected with ten clock dials. It is about to be introduced into Paris.

Melsens' Treatment for Lead Poisoning.—To a Belgian Professor, M. Melsens, the Paris Academy of Sciences awarded, last April, the prize of £100 founded by M. Anget de Montyon to encourage the invention of processes for diminishing the risks of unwholesome trades. This prize was decreed to M. Melsens for his method of curing and preventing lead and mercurial poisoning. The report of the committee appointed to examine into M. Melsens' process is as follows:

Thirty years ago Professor Melsens pointed out iodide of potassium as a means for successfully combating the ill-effects of lead or mercury on the human body. Experiments undertaken in conjunction with Professor Guillot confirmed the results first obtained by M. Melsens, who has since for a long period been pursuing his investigations and experiments.

Considering saturnine or mercurial affections as being due to the presence of metal in the organs which are the seats of those affections, M. Melsens administers graduated doses of iodide of potassium. The noxious metals are, by the action of this drug, carried away in the urine in the form of double scluble iodides, M. Melsens also advises the use of the iodide of potassium as a preventive in cases where menare exposed to the effect of lead dust or mercurial emanations.

Numerous experiments in the course of thirty years have proved the practical value of this system of treatment. Workmen affected with lead paralysis have been cured; others, who were unable to follow their calling from their liability to saturnine colic, have been enabled to take it up again, fortified by a regimen of which a dose of iodide of potassium formed part. The result of the observations made at Brussels and Lille, and the letters and certificates sent to the Academy, leave no doubt on the point.

With regard to mercurial affections, the observations made by M. Melsens in person have been confirmed by those made at the mercury mines at Idria. The workmen engaged in the manipulation of mercury and mercurial products at the Idria mines have been made the subject of various methods of treatment, curative or preventive, and the good effects of the iodide are no longer doubted.

At a special hospital in Vienna, ample occasion has been furnished to watch the action of the iodide in freeing the body from the presence of fixed mercury, and preventing its fixation. It has been found that in presence of the drug, the symptoms characteristic of the mercury are removed, or diminished, or prevented from declaring themselves.

The action of the iodide of potassium, according to M. Melsens' idea, is a purely chemical one. It consists in determining the metal rendered insoluble by the formation of some albuminous compound to take on a soluble form by the creation of a double iodide removable *per viam urinariam*. Whether this is the case, or whether its action consists in determining by destruction the evacuation of the morbid tissues containing the fixed metal, it is not the part of the committee to determine. It is sufficient that the author of this process has fully succeeded in diminishing the danger of certain mining and manufacturing operations.—*Iron Age*, April, 16, 1877.

—The J. C. Hoadley Company, of Lawrence, Mass., has designed and forwarded to Henry Meigs, the Californian who has become the great railroad builder of South America, portable engines intended to burn petroleum as fuel. Coal is so costly in the petroleum-producing region in Peru that the expense of the fuel is greater than the value of the petroleum. Meigs' idea is to make petroleum pump petroleum.—*Am. Manuf.*

—The Delaware Bridge Company of New York has been awarded the contract for rebuilding the Pennsylvania Railroad bridge over the Susquehanna river, five miles above Harrisburg, one of the largest bridges in the United States. It will be built entirely of wrought iron.

—Partial accouuts from Professors C. V. Riley and A. S. Packard, Jr., of their official investigations respecting the grasshopper, are given in the Western papers. The members of the United States Entomological Commission have made an extended trip through a large region of Rocky Mountain territory. The observations coincide in indicating that little trouble need be feared from the grasshopper during the present year in our Western States.

—Dennis H. Tierney, formerly of Waterbury, has invented and is now manufacturing in Forestville, Connecticut, a preparation for hardening steel, and its special and most valuable use for steel dies for drawing metal tubing of all kinds. He has dies in use that have already been used for drawing more than 50,000 pieces. Dies, as commonly hardened, have to be repaired every 10,000 pieces drawn for the same class of work. —*Iron Age.*

—The Hinkley Locomotive Works, at Boston, have sold several locomotives to the Galveston, Harrisburg & San Antonio Railroad. Their work has increased so much that they have been obliged to considerably increase their force.

Convenient Mode of Dispensing Ointments.—Dr. A. Van Hurlingen, in the *Philadelphia Medical Times*, speaks very highly of the advantages of a new method of dispensing ointments, on the suggestion of M. Jacques de May, a Parisian apothecary. Ointments were usually put in flat boxes of wood, porcelain, or glass, or in some cases in earthenware crocks, or in gallipots. The objection to this method is that a large surface is necessarily exposed to the air, and decomposition in a short time sets in, resulting in rancidity, which being applied to the inflamed surface would irritate where the opposite effect would be desired. There are some ointments, which in a few days become changed as respects the therapeutic effect, unless preserved with scrupulous care. In other cases the prescription would have to be frequently freshly made up at each time on account of the quality of rapid decomposition.

The new method alluded to has enabled Dr. Van Hurlingen to prescribe the easily decomposable ointments, and those containing volatile substances, with confidence, by employing a receptacle which will exclude the air at all times, and yet allow free egress to the ointment when required. This new method is a soft metal tube, such as is used to contain moist colors. Cylindrical in shape, open at one end, and closed at the other by a tap of stiffer metal, having a neck like a bottle and a threaded cap that can be screwed down so as to exclude the air perfectly. It is even fitted with a piece of cork at the top like the lid of a traveller's inkstand. The ointment in a melted condition is poured in the open end, which is then pressed together and folded over the soft metal, permitting it to be perfectly sealed by this means. When required for use only a sufficient quantity may be pressed out, the screw replaced, and the ointment in the air-tight case may be laid aside until needed Tubes of this kind may be of various capacities, and have been employed largely in dispensary and private practice with great satisfaction.

—Twenty-five of the principal commercial and manufacturing firms of St. Louis have recently dispatched an agent to Venezuela with samples of iron goods, tin and metal ware, wire fence, gas machines, articles for Catholic Church service, agricultural implements, furniture, trunks, carriage, furnishing, bagging, matches, soap and candles, beer and ale, books and stationery, perfumery fancy goods, provisions, etc., and are expecting to inaugurate a large and lasting trade. Such enterprise so directed will greatly aid the revival of business and assist in creating the activity the whole country requires. The trade can be transacted either via Galveston or New Orleans, and St. Louis will perhaps become a large coffee center. At all events the endeavor is auspicious and of the right kind and timely.—*Iron Age.*

—The Portland Locomotive Works have obtained the contract to change the gauge of the engines of the European and North American, and of the Piscataquis and Bangor Railroads. The company is also building 35 cars for the Burlington and Lamoile Railroad, to be delivered very soon, in addition to which it has just delivered to the Western Counties Railroad of Nova Scotia three new and powerful locomotives, and are building others for the North Shore Railroad of Canada.

—Some three months ago the Reading Railroad Company sent out two agents to South America to endeavor to open up a new market for their coal. The agents will visit Rio Janeiro, Para, Montevideo and other points on the Atlantic coast, pass through the Straits and stop at all places of importance on the Pacific Coast as far up as San Francisco. They carry samples of coal with them. The party will return in about six months' time. Until their return it is not likely that any shipments will be made.

—C. A. & W. L. Teal, of Philadelphia, are at present engaged in the construction of a novel form of steam engine, which entirely dispenses with the universally used crank motion, and developes at any point of the stroke, the full power of which the latter is capable at the point of its greatest leverage. The reciprocating piston is used, and the only change from the ordinary engine is in the mode of transmission of the motion from the reciprocating to the rotary.—*Am. Manuf.*

—Two of the large silk factories of Paterson, N. J., have received orders from Paris for the manufacture of a certain description of silk goods.

—The Ames Company, Chicopee has a contract to furnish the Turkish government 200,000 scabbards, to do the leather work for which it will take forty men fourteen months.

—The Hitchcock Lamp Co., of Watertown, N. Y., is about to place some of its lamps in the cars of the Chicago & Alton Railroad on trial. Their lamps are highly spoken of for illuminating railway passenger cars.

—The trade in flour between this country and Brazil is now considerable in amount. The other week a steamer cleared at New York for Rio de Janeiro, having on board over a thousand barrels of Baltimore flour.

EDITORIAL CORRESPONDENCE.

ERRORS IN TABLES.

To the Editors of the POLYTECHNIC REVIEW:

Mr. W. A. Collord, of Cincinnati, has kindly informed me of an error on page 56 of my "Civil Engineer's Pocket Book," namely: the cube root of 936 should read 9.7819, instead of 9.7829. The same error exists in the old edition of Barlow, (always considered almost infallible) and in Haswell, Nystrom, Weale, and all the authorities to which I have referred, except the edition of "Barlow's Tables" recently published. Inasmuch as it is a matter of much importance to engineers that their tables should be correct, I hand you this for insertion in the "REVIEW" if you see fit. With the same object I will add that on page 30 of Rankine's "Rules and Tables," London, 1867: the square of 967 should read 935089, instead of 939089.

I think it would be well if engineers generally would publish such errors as they may chance to detect in books of common office reference.

Yours, respectfully, JOHN C. TRAUTWINE.

WILMINGTON, Delaware, August 13th, 1877.

EDITORS POLYTECHNIC REVIEW:—

The latest information seems to indicate that the "Beet Sugar Industry" is not an assured success in California, as stated in my pamphlet. The crop of beets was only 3½ tons per acre last year. Respectfully,

LEA PUSEY.

PHILADELPHIA, Aug. 21st, 1877.

Editors POLYTECHNIC REVIEW:

Allow me to correct an error at the end of my letter published in No. 2 of your valuable paper. The simplified Lamé formula for the thickness of cylinders for hydraulic presses, being expressed by

$$\text{Thickness} = \textit{inner radius}\left(n + \frac{n^2}{n}\right)n$$

means the bursting pressure divided by the cohesion of the material, and not the cohesion divided by the pressure.

Yours respectfully, A. SCHLEICHER.

BIBLIOGRAPHICAL NOTICES.

THE MAGNETISM OF IRON VESSELS. With a short Treatise on Terrestrial Magnetism. By Fairman Rogers. (125 pp. 18mo, boards. Van Nostrand's "Science Series," No. 30.)

While the marked influence of the hulls of iron vessels upon their compasses has been noted for more than fifty years, and indeed was the subject of a memoir in the *Philosophical Transactions* more than forty years ago, it has been only within the last fifteen or twenty years that the increasing use of iron vessels lent importance (or rather called much attention) to the subject. This little treatise was prepared as part of a manual similar to the English *Admiralty Manual of Scientific Enquiry;* but as our Bureau of Navigation decided to abandon the projected work, this portion of it was given to the public in *Van Nostrand's Magazine.* It is of importance to all navigators, who we hope will be led by it to continue experiments bearing upon the subject. There is a new and specially valuable table analyzing the elements of deviation.

THE POPULAR SCIENCE MONTHLY for September opens with another able original paper, by Herbert Spencer, on the development of the domestic relations, in which he indicates some of the most important lines of future social progress. The next article, "Odd Forms among Fishes," is by the late Prof. Sanborn Tenney, who, with the aid of numerous illustrations, gives a very entertaining account of sundry curious divergences from the typical pattern in this division of animal life. The Observatories of Italy, of which there are no less than ten, under the patronage of the government, are briefly described in the third article, with the work that each is doing. "On Drops" is a short but fully illustrated account of some remarkable experiments, showing, by the aid of electric illumination, the curious shapes which drops of fluid take on striking a hard surface. "Civilization and Morals," by Mr. J. N. Larned, is an instructive discussion of man's various relationships, and how out of these has grown up his present system of morals. The eighth article, "Instinct and Intelligence," by W. K. Brooks, of John Hopkins University, is of great interest, as tending to show that the distinction hitherto erected between men and animals in this regard has no actual existence in Nature. Among the five other papers that go to make up the body of the magazine, all of which will fully repay the reader, there is a short but incisive article on "The Labor Question," written before, but bearing directly on, the recent strikes; and a sketch, with portrait, of Prof. Simon Newcomb, the distinguished Director of the U. S. Naval Observatory at Washington, and the present President of the American Association for the Advancement of Science. The departments including Correspondence and Editor's Table, are, as usual, full of interest and instruction. They contain pointed discussions of current scientific questions, notices of the latest scientific books, and, in the Popular Miscellany, brief but clearly written abstracts of recent papers, and descriptions of new discoveries from the principal centres of scientific activity both at home and abroad.

SELECTED LIST OF U. S. PATENTS.

JULY 24, 1877.

Patents granted July 24, 1877, 278; Reissues, 13; Designs, 29; Trade Marks, 39; Labels, 6.

193,314. FINISHING GLASSWARE. G. W. Blair, Pittsburg, Pa.

The "sulphuring" of glass in a furnace for reheating and finishing the article is prevented by injecting steam into the flame of the combustion chamber, it having the effect to destroy or neutralize the objectionable discoloration.

193,315. PRINTER'S LEAD SHAVING MACHINE. Claus G. Blomgren, Oscar N. Blomgren and Susan A. Hawkinson, Chicago, Ill.

The blanks are inserted one by one, and are carried by feed rolls along, to be acted upon first by a cutter to true the blank; secondly, revolving cutters to cut away the face of the blank to make the lead of uniform thickness; thirdly, the finishing cutter shaves off the ridges formed by the revolving cutter, and lastly, the edges are shaved and trued.

193,327. MACHINES FOR CUTTING PAPER, ENVELOPES, &C. E. J. Frost, Philadelphia, Pa.

Paper is fed off a reel, and the slack taken up by a gravitating beam roll. Continuously rotating feed drums convey a proper length of web previously rolled off to the cutter, which latter is constructed of a shape to produce the article required. The upper feed drum is made in sections, each of which has a portion of its periphery raised, and they may be adjusted with relation to each other in order to vary the length of the sheet to be severed. Eccentric cams are suspended above the sheet to prevent back-lash after being fed to the cutter.

193,329. STEAM BOILER. J. Gates, Portland, Oregon.

An auxiliary combustion chamber is formed between two sections of a boiler. Water communication is established by an annular outside chamber through perforations in the shell in each section. Said annular chamber also communicates with the steam dome.

193,390. PORTABLE BURGLAR ALARM. I. B. Woodruff, Winstead, Conn.

This alarm apparatus is designed to be attached to the door knob, and to be set in operation by the turning of said knob if any person endeavors to open the door. To this end it has the ordinary alarm mechanism attached to a plate and arranged very compactly. A clip serves to attach it to any ordinary door knob, and the mechanism latch is tripped by the swing of a weighted lever when the knob is rotated.

193,407. APPARATUS FOR MANUFACTURING ILLUMINATING GAS. W. S. Hill, Hyde Park, Mass.

Air is forced into a regulating receiver and thence into the carburetting chamber. A constant circulation is maintained through a coil of pipe in a receiving chamber, which thus acts as a condenser to the carburetter. The gasoline is also constantly circulated through the carburetting chambers for the purpose of preventing deposits of heavy oil in the chambers.

193,472. FURNITURE CASTER. S. E. Bander, Birmingham, Ohio.

The ordinary drop caster is provided with a short leather strap perforated at one end for the reception of the tang of the caster, and at the other end tacked to the end of the table leg. When the caster is in position and operating, its tang simply revolves in the perforation of the strap, but when the article of furniture is lifted up and the caster would otherwise drop out, the slight friction against the leather will cause it to clamp and pull the tang against the sides of the socket, and prevent it from dropping out. This little device, from its simplicity, inexpensiveness, and complete utility in correcting an annoyance almost universal, is admirable.

193,488. HEATING APPARATUS FOR VACUUM PANS. D. B. Cobb, Jersey City, N. J.

A steam belt divided by horizontal circumferential partitions into an upper and lower compartment, supplies steam to the radially arranged heating chambers contained within the pan. The syrup circulating freely between them is exposed to a large extent of heating surface, prompting rapid evaporation. The radial chambers are alternately connected with the upper and lower compartments of the steam belt, so that steam may be entirely cut off from either set at will, for reducing the quantity of heat, etc. The inlet to each chamber is accessible through an opposite hand hole in the belt, and may be plugged up when desired Outlet pipes from the radial chambers are provided for the escape of condensed steam and air.

193,506. HYDRAULIC FIRE ESCAPE. J. F. Greene, Brooklyn, N.Y.

A series of telescopic tubes connected at bottom with a hollow pivoted chest, serving as a universal joint, is mounted upon a truck. The base is connected with a force pump. A rope ladder and stays are attached to the upper end of the tube.

193,509. PRESERVING ANIMAL SUBSTANCES. J. Harvey, London, England.

The meat, fish or other animal substances are placed in a close chamber and subjected to the action of nascent sulphurous acid, obtained free from injurious impurities by the combustion of bisulphide of carbon, which may be burned within said chamber in an open shallow disk or an ordinary spirit lamp.

193,520. ART OF TANNING. F. Knapp, Brunswick, Germany.

Hides are tanned by steeping them in a solution of basic sulphate of iron produced by first boiling a solution of ordinary green vitriol (sulphate of iron) and nitric acid to oxidize the iron salt, and then adding more green vitriol until the solution becomes of proper consistency.

193,539. EVAPORATING PANS. J. W. Miller, Scotland, Ind.

The juice and syrup are separated from each other in different chambers by valves at alternate ends of the chambers. The dirt and scum are caught in sinks at alternate ends of the chambers, and from thence they are drawn off by drain pipes leading from the bottom of the sinks.

193,540. PROCESS OF CONVERTING IRON SCRAP INTO BARS. A. J. Moxham, Louisville, Ky.

Wrought iron scrap is converted into merchantable iron without subjecting it to the ordinary muck process, by first forming the scrap within the furnace into a suitable bloom, and then removing said bloom therefrom and subjecting it to hydraulic or other pressure, whereby a condensed bloom is formed and prepared for immediate conversion into bar or other shaped iron, as may be required.

193,571. COTTON CARDING ENGINES. G. E. Taft, Northbridge, Mass.

The top flats are arranged in advance of a group of workers and clearers over the main cylinder, for removing the trash, &c., before the fibres reach the group of workers and clearers. The space for these top flats and workers and clearers is increased by dropping the feed rolls and doffer below the axis of the main cylinder. To strip the main cylinder of any fibre that may escape the doffer a roll is arranged beneath the leader-in roll, and between this roll and said leader-in is located a breaker roll, for opening any bunches that may reach the leader-in from the feed rolls.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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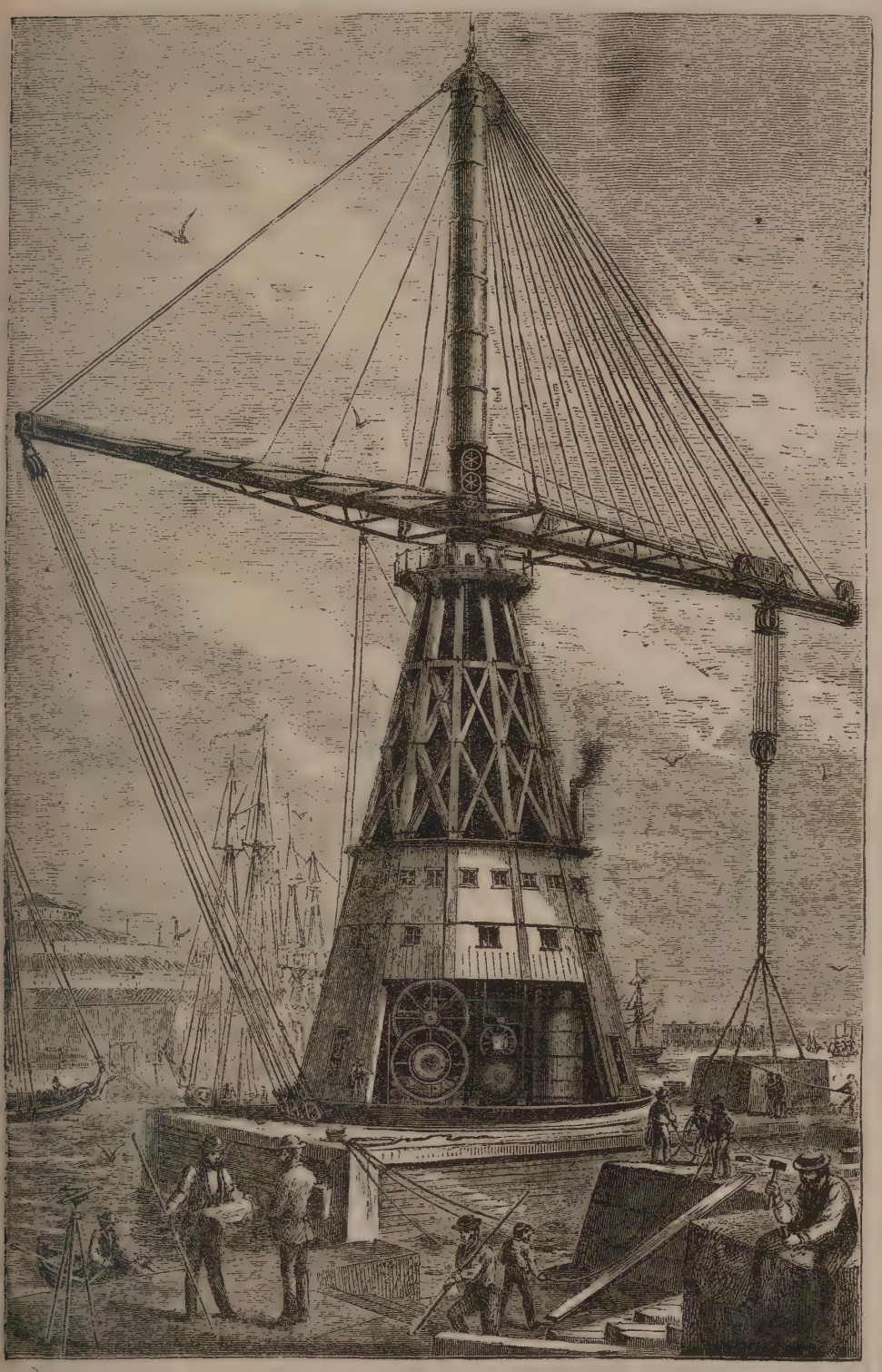


THE FLOATING DERRICK OF THE NEW YORK DEPARTMENT OF PUBLIC WORKS.

The derrick is originally a nautical invention, the original being the sailor's contrivance made of a spare topmast or a boom with the appropriate tackle. This simple contrivance is even now used on shipboard for masting, and for placing boilers, engines and other heavy articles on shore. The derrick is more commonly used in the United States than in Europe, and has in consequence acquired a corresponding degree of perfection. The Floating Derrick which we herewith illustrate is "Levytyped" and described from *Knight's Am. Mechanical Dictionary*. This derrick is in use in the New York Department of Docks, and was built under the supervision of Mr. Newton, assistant engineer of the department. It was constructed expressly for the purpose of transporting from the work-yards the blocks of granite and artificial stone that are to form the river wall. Its lifting and carrying power is 100 tons; the float which carries the derrick is of rectangular form, 66 by 71 feet, and 13 feet in depth. The tower which supports the king-post and booms is made of twelve balks of pine, 63 feet 3 inches in length and 14 inches square. These balks or legs are stiffened from one end to the other by struts and braces; their lower ends are bolted into a heavy cast iron circle which pass through the bottom of the floor. At their upper extremity these legs are brought close together and are inserted in a cast iron cap, to which they are bolted. The tower forms a frustrum of a dodecagonal pyramid, 40 feet in diameter at the base, 52 feet in height and 12 inches in diameter at the top. The front or hoisting boom of the derrick consists of two wrought iron box girders, 22 inches deep by 9¾ inches wide. These girders are made of planed plates, are spaced 24 inches asunder, and are held parallel by braces of wrought iron; on the upper and inner edges of these girders a track or slide of polished brass is fastened by counter screws. These tracks have a projector which extends a short distance downwards; the carriage is composed of two plates of iron, ¾ of an inch thick and spaced 10 inches asunder; its length is 8 feet, its depth 3 feet. The iron boom is supported by 18 diagonal rods, 2⅛ inches in diameter. These converge near the top of the king-post, and are secured to it by three heavy forgings which straddle the iron cap on the top of the post.

The king-post is of wrought iron, 40 inches outside diameter. It is hollow, and its shell is three-fourths of an inch thick. It revolves in a circular casting, swinging the boom completely around.

All the machinery is placed on the float under the tower, and the levers which operate it and give the various movements are brought together on a platform 35 feet above the deck of the float, so that the person operating them acts in full view of the load that is being handled. O.

TEMPERING AND ANNEALING STEEL.

If we "temper" any metal—that is to say, cool it rapidly—the effect is to cool the exterior layer first; and the rapidity with which this is effected depends (1) upon the difference of temperature between the metal and the cooling liquid, and (2) upon the conducting power of the liquid.

The effect of sudden "quenching" is to contract the already enlarged external layer strongly upon the also enlarged uncooled interior portion, putting both in a state of stress; the inner being in compression and the outer in tension, the latter being stretched to a degree dependent upon the completeness of tempering. If the tempering is but slight, this stress will not exceed the limit of elasticity of the material, and on cooling, the extension will disappear.*

During the second tempering stage, the cooling extends to the centre, contracting the central fibres; but these, being bound to the external layers which have exceeded their elastic limit, must stretch at the expense of their elasticity, as they contract; and at the same time they contract the external fibres.

We find, then, that a tempered body has existing within it strong molecular forces balanced by molecular tensions. We can show this by taking a square bar of tempered iron and cutting it in two lengthwise on a planer; each half, when released, assumes a curved form, with the concavity on the newly-planed side, showing that there was a tension on the inside of the bar, resulting from the second stage of tempering. If there had been a tension in the external layers only, the bending would have been in the opposite direction.

The art of tempering increases the volume of bodies, as shown by the experiments of Caron, here tabulated:

(Cast Steel.)	Natural State.	At Red Heat.	After Tempering.
Length	20.	20.32	19.95
Width	1.	1.03	1.01
Thickness	1.	1.53	1.01
Volume	20.	20.557	20.351

In these bars of cast steel we have an increase of volume caused, although the length lessened, the tendency being to assume a globular shape.

A bar of *rolled* steel gave these results:

(Rolled Steel.)	Natural State.	After Tempering.
Length	20.	20.45
Width	1.51	1.51
Thickness	3.70	3.70
Volume	111.74	114.25

the width and thickness being undiminished, but the increase having taken place in the *length*, the longitudinal fibres having exceeded their elastic limit lengthwise before that limit was reached transversely.

In steels and other materials in which carbon is present in mixture or in solution, the problem is complicated because temperature and pressure affect the amount of solution. We can only, reasoning from analogy, assume that the increase in volume does not result from an increase in the amount of carbon actually dissolved in the iron; because a solution never has greater volume than the total bulk of the bodies composing it, but frequently has less. However, we may say that the pressure resulting from tempering holds in solution some of the carbon that would have been precipitated or separated by slow cooling; and the quicker the tempering, the greater this pressure and the amount thus held in solution.

A mixture of irons carburized in different degrees would be blended under tempering pressure; that is, diffusion of carbon would take place, just as in the cement-

*In breaking cast-iron blocks by heating them red and then quenching them in a stream of cold water, the limit of elasticity of the exterior layer is exceeded; cracks appear therein, and the block is readily broken up by comparatively slight blows.

ing process a bar absorbs carbon from without, and as in making malleable iron the decarbonizing packing draws it out. But no amount of tempering can produce pressure enough to dissolve all the carbon in steel. Annealing, or slow cooling after high heat, in a time proportionate to the size of the body, allows the metal to recover the elasticity it lost under tempering pressure, and prevents undue strains. In steels annealing also produces the separation of part of the dissolved carbon, and, to produce homogeneity, must be very slowly and evenly performed.

Annealing at too high a temperature—near the melting-point—would destroy the fibrous texture caused by forging, and slow cooling would crystallize it; the piece would have no elasticity—would be "burned."

Highly carburized steels reach the elastic limit in tempering at a very high point, and hence the same degree of cooling produces in them more compactness and pressure than will slightly carburized metal, and gives us a hard, tenacious, brittle material.

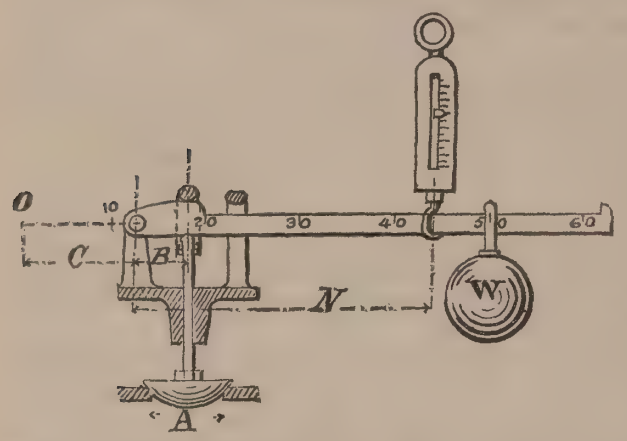
Tempering followed by annealing improves non-homogeneous irons, (1) by the heating producing solution and dissemination of carbon; (2) by the tempering pressure increasing this dissemination; (3) by the heat of annealing continuing the effect produced; and (4) by the slow cooling permitting the molecules to so group themselves as to nearly remove internal strain.

Often, tempering gives the hardness, tenacity and homogeneity, and *partial* annealing is resorted to to *partly* restore elasticity. This is seen in armor plates, where partial annealing, while decreasing their resistance to *penetration*, decreases also their liability to break under blows. But *reducing the intensity of temper would produce the same result.* Caron produced with the same hardness, tenacity and elasticity, (1) steel springs admirably tempered and annealed, and (2) springs of the same metal, simply tempered in *hot* water, and unannealed. Caron also regenerated "burned" iron by tempering in a sea-salt solution of 110° C., restoring the primitive texture by temper-pressure, and then restoring the elasticity by slow cooling. Heating to a white heat and then hammering produces the same result; and, in fact, tempering is a forging action, drawing out the metal by molecular pressure. G.

CALCULATION OF THE LEVER FOR A SAFETY VALVE.

[Mr. Robert Briggs, C. E., who is well known as a former manager of machine-works in this city, sends us the following rule for calculating the levers of safety valves, which he prepared many years since for the instruction of apprentices. We think it will be found simpler and more easy of comprehension by practical men than some of the rules laid down in the general handbooks.]

1st. Take area *A* very carefully and multiply by 10 lbs. (or whatever unit of pressure per square inch is taken to form a division of the lever).



2d. Measure the fulcrum distance *B* in inches from the valve centre with great accuracy, and multiply the dimension in inches resulting by 10*A*; and 10*AB* equals the *moment* of the pressure on the valve at 10 lbs. pressure per square inch on the arm *B*.

3d. Ascertain the weight *W* of the ball, or assume a weight *W* which it is desirable to use, and divide the moment (2d) by this weight; the result is the length in inches of each division of the lever, which will indicate 10 lbs. pressure per square inch on the valve surface.

4th. Having removed the weight (*W*) from the lever, hook on a spring balance at some ascertained distance *N* (in inches) from the fulcrum, and lift the lever, valve spindle and valve from its seat by the balance. Take the weight indicated and multiply it by *N*, and the result will be the *moment* of the weight of the lever, etc., about the fulcrum. [In place of a spring balance, any application of a scale which shall get the weight at the end of *N* will suffice.]

5th. Divide this moment by the weight *W* of the ball, and the result will give the length of an imaginary line (*C*) behind the fulcrum, on the end of which the ball should be hung to balance the lever, valve, etc.

6th. From the end of this line (*O*), as a new point, the divisions (3d) commence, and are to be carried along the lever, as shown on the drawing.

IRON BENCH PLANES.

Probably until lately there has been a less degree of improvement in the hand tools of the carpenter and joiner than in those of any other mechanic, the "kit" of a joiner of the last generation differing from one of the present mainly in superior finish of the tools, but not in their forms or materials. Take the most commonly used tool, the plane, from time immemorial a block of beech or rosewood with an "iron" passing through it diagonally and held by a wedge set up by the hammer, the setting of the iron sometimes occupying several minutes; first a rap with the hammer, next a squint with the eye, then a trial of the plane, to be followed by the same series of movements in the same order repeatedly. If the end of the grain is to be planed, a plane with the iron set at a more acute angle to the face of the plane is required than one for planing with the grain. Sometimes it is found that the throat of a new plane is too contracted, and when enlarged it is too free, and then a piece must be let in to get the proper opening. The wood of the plane is of course subject to hygrometric influences, and the face of the plane gets out of true, and must be dressed with a long jointer and trued by the eye and a couple of try-squares. Now it would seem feasible to make a plane of metal that would not warp, to set a plane iron by a screw that acts gradually and positively, and to make the aperture of the throat adjustable so that a plane could be worked on hard and soft woods and either with or across the grain. All this has been accomplished, the result being superior in every point of usefulness to wooden planes. The body of the plane, instead of being a block, is a bottom and two sides, a light iron casting which receives the plane iron and its holder. The iron is set by turning a knurl which actuates an eccentric or cam, connecting with the iron by a link and throwing it forward or withdrawing it as it is turned in one or the other direction. The iron is secured, when adjusted, by a set screw turned by hand; the front end of the face is movable, sliding forward or back, and enlarging or diminishing the throat. No screw driver, wrench or hammer is required in the adjustment of the tool. The size of the plane does not make it cumbrous, the twenty-four inch jointer being more easily handled than the ordinary wood plane. A circular plane working on a radius of seventeen inches, with capability of expansion of the flexible face, is also made of metal, and a combination plane, which is a plough, filletster, back filletster, dado, rabbet, and match plane, without a particle of wood in its composition. J. H. L.

COLD-ROLLED SHAFTING.

Transmissive shafting is subjected chiefly to torsion, although it has of course a certain bending stress, caused by its own weight and that of the pulleys it carries, and by the thrust of gearing and pull of belting. Rotary shafting was, in olden days, of timber, which cast iron superseded, to be in turn driven out by hammered, and then hot-rolled wrought iron, turned to dimensions, and now most largely used. The great weight and cost of such shafting is an item of expense which it is desirable to lessen, the first cost being heavy, and the weight necessitating heavier and more frequent supports and hangers, and stouter couplings and heavier frame work to bolt to. Falling shafting is not a nice thing to dodge in a burning building, and firemen bear it in mind, and sometimes a shop suffers for this reason.

The ordinary wrought iron shafting was a great advance over the clumsy cast iron, being lighter and stronger in longer sections, and requiring less turning to work to gauge. Our American makers work to sixteenths, the English to eighths, so that a $2\frac{1}{2}''$ round bar makes with us a $2\frac{7}{16}''$ shaft, but with the English, only a $2\frac{3}{8}''$, in both cases the finished shaft receiving the name of the sized bar it was turned from.

There is of course greater economy in metal and labor in the American practice, but both of them have these faults—the metal chosen is not the strongest obtainable, and its strongest and most valuable portion, the outer annulus or skin, is removed by turning, at considerable expense. As the beneficial or toughening effects of rolling are comparatively greatest on the smallest diameters, and as the removal of a one-thirty-second cut from a small shaft weakens it proportionately more than it does a larger, we find the smaller sizes suffering markedly. Thus, if we reduce a $2\frac{1}{2}''$ bar from $\frac{40}{16}$ to $\frac{39}{16}$ in diameter, we reduce its area in the proportion of 40^2 to 39^2, or 1600 to 1521, that is, the $2\frac{1}{2}''$ bar has $\frac{1600-1521}{1521}$ = over .052 greater section than the so-called $2\frac{1}{2}''$ shaft; and the 5 p. ct. removed is the best part of the bar. Where a $2''$ bar is reduced from $\frac{32}{16}$ to $\frac{31}{16}$, the proportional sections are as 32^2 to 31^2, or 1024 to 961; the bar having $\frac{1024-961}{961}$ = .065 more section than the turned shaft, which can ill afford to miss the removed portion. This practice of removing the best portion of castings, forgings and rolled bars, reminds one of the boy who stripped all the bark off his sassafras roots, and chewed the wood only. As the sole use and intention of turning off the round bars is to remove the roughness and crookedness which they invariably possess when they leave the roll-passes, the invention of planished shafting is a great improvement.

By passing the bar while hot between rapidly revolving beveled rollers, the scale is stripped off, the inequalities in diameter reduced, and the bar straightened. By this plan the expense of the barbarous custom of turning off is saved, and the best part of the shaft is not removed; the process thus retains the maximum benefit of the hot rolled bar. But we may go beyond this point again, and by actual compression of the whole bar by cold rolling, may so compact and toughen the fibre, as to produce results far beyond any attainable by the hot rolling process. The metal is not only compacted into a smaller space, but is given greater torsional and bending resistance per given weight as well as section. Mr. F. H. Morse, in the *Northwestern Lumberman*, Dec. 23, 1876, quotes the following statistics concerning hot rolled *vs.* cold rolled shafting:

	Hot Rolled.	Cold Rolled.	Ratio of incr'se in strength, c'ld rolled	Average rate per cent. of increase.
The weight which gives a permanent set of one-tenth of an inch to transverse bars supported at both ends—30 inches between the supports, weight applied in the middle:				
Half-inch square bars	3,100	10,700	3,451	
Round bars, 2 inches in diameter	5,200	11,000	2,134	162½
Round bars, 2½ inches in diameter	6,800	15,600	2,294	
Torsion.—The weight which gives a permanent set of 1°. When applied at 25 inches from centre of bar, 9 inches between clamps:				
Round bars, 2¾ inches in diameter	750	1,725	2,310	130
Compression.—Weight which gives a depression and permanent set of $\frac{1}{100}$ of an inch to columns 1½ inch long by ⅝ inch diameter	13,000	34,000	2,615	161½
Weight which bends and gives a permanent set to columns 8 inches long by ¼ inch in diameter:				
Puddled iron	21,000	31,000	1,476	64
Charcoal bloom iron	20,500	37,000	1,804	
Tension.—Weight per square inch at which rods ¾ inch in diameter stretch and take a permanent set:				
Puddled iron	37,250	68,427	1,837	95
Charcoal bloom iron	42,439	87,396	2,059	
Weight at which rods ¾ inch diameter break:				
Puddled iron	55,760	83,156	1,491	72
Charcoal bloom iron	50,927	99,293	1,950	
Hardness.—Weight required to make equal indentions	5,000	7,500	1,500	50

G.

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

CREMATION.

The cremation of the mortal remains of the late Dr. Charles Frederick Winslow, which, in accordance with the last wishes of the deceased, was successfully performed at Salt Lake City on the 31st of July last, furnishes the third instance of this method of disposing of the dead that has occurred in the United States, if we except from the enumeration the cases of certain aboriginal tribes which have long practised the cremation of their dead. The first case referred to is that of the revolutionary General Laurens; the second, that of the Baron de Palm, which occurred quite recently, and the last is that of Dr. Winslow, which has just transpired. The occurrence of the last event, involving the name of a gentleman widely known and esteemed for his eminent scientific attainments and the purity of his personal character, has again attracted attention amongst thinking circles to this method of disposing of the dead, which the concurrent opinion of scientific men, and an intelligent regard for the health of the living, pronounce to fully meet the sanitary requirements of large cities, to be free of offense to the proprieties, rational and effective.

The following remarks, abstracted from one of the addresses delivered on the occasion which prompted this article, are well worth perusal, as briefly and sensibly covering the ground involved in the cremation controversy:

"As to the disposition of the human body after death, we may divide the people of our modern civilization, in accordance with their opinions on this subject, into two classes, the majority and—I cannot say the minority, but rather the exceptional few. The majority, on account of early education, habits of thought and sentimentalism, look upon any other disposition of the body than that by inhumation as an almost sacrilegious tampering with the human remains. They want to bury their dead from their sight. They want to consign them to the bosom of mother earth—the earth from which they sprang—that the dust may return to dust. Theoretically this is what they desire, but it seems by no means what they attempt to accomplish in practice. They do indeed bury their dead from their sight, but every effort is made, by metallic and air-tight coffining, and even by embalmment, to retard the return of dust to dust by the exclusion of the three factors, air, earth and moisture, which are concerned in the reduction. The only proper method of burial, to accomplish the end in view, is that which is given the soldier on the field on which he fell—in his own or somebody else's blanket. But even at best the return of dust to dust by this method is a slow process, during the progress of which many noxious gases are evolved and many complex organic substances generated, to taint the air we breathe and poison the water we drink. To us in Utah this is a matter of small moment, as we have ample space for both our living and our dead, but in more settled communities, and especially in the crowded centres which our civilization has developed, the question of what shall we do with our dead is one of vital importance to the living. The exceptional few have answered this question by suggesting cremation, in which fire is made to accomplish in a few hours the work which air, earth and moisture require years to effect. The oxidation which proceeds so slowly in the soil and with the evolution of so many deleterious products, is transformed in the furnace into a quick and perfect process; no more taint from the dead in the air which is breathed by the living, no more poison from the dead in the waters which the living use, nothing but the white ashes of our dead remain in the furnace after this purification by fire. We shall all have to cremate and be cremated in the long run. It may not be in our time, but for the sake of the living our posterity will have to come to it. The people will have to change their habits of thought on this subject, and educate their sensibilities to the idea of cremation instead of burial. At the present time every fresh case is a step in this process of education; and the time will come when the people of this country will look upon the memory of Dr. Winslow as I now do, as of one who proved a benefactor to his kind, by teaching them in his own person how to dispose of their dead."

W.

IMPROVEMENTS IN TUYERES FOR BLAST FURNACES.

In that period when the blast used in iron smelting was employed in the cold state, no inconvenience or trouble was experienced from the melting, and therefore, leaking of tuyeres; for the simple reason that when cold blast was used the intermediate space in front of the tuyeres was black from want of heat. The tuyere then used was merely a piece of plate iron bent into the shape of a funnel and inserted into the walls of the furnace. But when James B. Neilson came upon the ground with the hot blast, the space directly in front of the tuyeres was no longer black, but was changed to a red glow. However, he experienced no trouble when he raised the temperature of his blast to 240° F., but finding that he could utilize more heat in the blast, he raised it to 600° F., when the space in front of the tuyere became white hot, which burnt both tuyere and nozzle. At this juncture, the long-to-be-remembered John Condie, of the Blair Iron Works, appeared with his water tuyere, which consisted of a spiral wrought iron pipe covered with clay, and through which water was continually forced. He also invented the double cylinder wrought iron tuyere, which has a water space between the two cylinders. These two forms of tuyeres have ever since been employed, and modified forms of them are the only ones now in general use.

The eminent iron master of Great Britain, I. Lothian Bell, in experiments upon the effect of the slag in a blast furnace upon fire clay in the solid form as brick, found that, when introduced into the furnace, it was quickly corroded and disintegrated by the highly heated slag in its descent, and that from his experiments, he thinks that it is alone the coating of deposited carbon, from the dissociation of CO in the upper part of the furnace, which prevents the great continual wear of the firebrick lining of the furnace. Now, with Condie's tuyere, covered with fire-clay, it is impossible to have this deposited carbon upon it as a covering, as the incoming blast would blow it off, and also its oxygen would combine with this incandescent and nascent carbon to form CO, and therefore the heated slag would in a short time cut away the clay and leave the wrought iron pipe coil exposed to the intense temperature of that part of the furnace.

The following tuyere, (Fig. 1) as manufactured by the Weimer Machine Works, of Lebanon, Pa., is somewhat similar to Condie's spiral form. The principal feature of this tuyere is, that a grooved shell of iron is first cast and the coil of pipe then coiled upon it, thus preventing any injury by the liquid iron in casting.

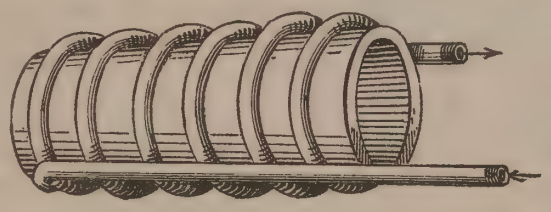


Fig. 1.

The tuyeres, as manufactured by the Olive Foundry, Machine Shops and Boiler Yard, of Ironton, Ohio, are superior in many respects to most others, and are modeled after Condie's second improvement. They are shown in the following sketch:

They consist essentially of two conical frustra which are joined at the ends by ring pieces; the space between them being occupied by water. The whole tuyere is made of the best wrought iron plate, and by the most experienced workmen. These tuyeres are now in use all over the country, but particularly so in the Hanging Rock iron region, where their value is well known.

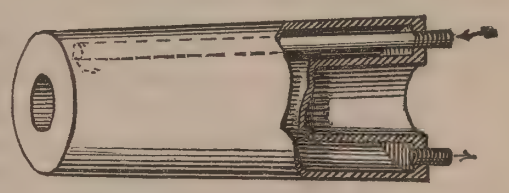


Fig. 2.

Being of the best wrought iron, a temperature of over 3000° F. would be necessary to melt them were there no water constantly flowing through them, while with those of cast iron, 2700° F. would suffice.

The water in tuyere Fig. 2 has also a better chance to do its duty than in those of the form represented in Fig. 1.

In the former (Fig. 1) we cannot of necessity have close contact between the wrought iron pipe in coil and the cast iron conical piece, and therefore the conduction of heat from the outer end of the tuyere cannot be perfect, as any air space, however small, acts as a non-conductor to heat. This renders the tuyere more liable to burn and melt than that of form Fig. 2; also, the melting point of the cast iron of this tuyere, being much lower than that of the wrought iron tuyere, is still further lowered by this non-conduction of heat by the air. Every tuyere of the form Fig. 2, as made by the Olive Works, is tested to a high water pressure before leaving the works. In addition to their general form of tuyere, they also make a cast iron tuyere, which is shown in Fig. 3. In shape it resembles the wrought iron form, but in the smaller end they have a circular piece of pipe, as shown, and which is perforated with holes. By this form of water supply pipe, they have the coldest water thrown over the whole surface of the inner portion of the tuyere next to the interior of the hearth. In this tuyere the water has also direct contact with the surface of *all* the iron of which the tuyere is composed.

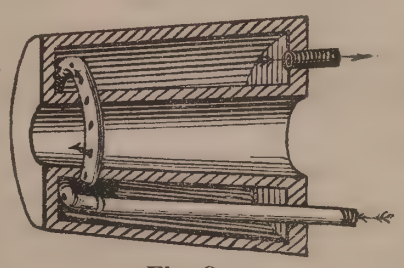


Fig. 3.

The importance of knowing a leaking tuyere is well known, and in the generality of cases it is only known by the chilling effect in the hearth produced by the leaking water. The Olive Works of Ironton have a small apparatus which they attach to their tuyere, and which acts as a tester and tell-tale to any leaking tuyere. By its attachment, great loss of time and money may be saved.

The water tuyere, though small in itself, is of the utmost importance to iron smelters; in fact I think I can safely say that it has proved to be almost as important as the closed hearth system to blast furnaces invented by Mr. Luthermann.

R. M. HUNTER.

The Whitwell hot blast stoves being erected by the Crane Iron Co., Catasauqua, are rapidly going ahead, but several months must elapse before they will be ready for use.

IMPROVEMENT IN LIFTING-JACKS.

Patented April 24th, 1877, by Frederick Griscom, of Dolington, Pa.

"Fig. 1 represents a side view, partly in section, and Fig. 2 a plan of a lifting-jack constructed according to this invention.

A represents the frame or stand of the device, which is provided with two vertical standards, A^1, A^2, to which are pivoted or connected the working parts, as hereinafter described.

The standard A^1 at a is provided with a groove or guide, b, adapted to engage with a corresponding guide or groove, b^4, in the face of a sliding toothed lifting bar, B, which is held securely in position against the standard A^1 by means of face-plates, b^1, b^1, bolted or connected to the standard A^1, and which, at their forward edges, are turned over or formed with a rim or guide, b^2, adapted to run in grooves or channels, b^3, in the lifting bar B. C is a pawl or ratchet lever pivoted in a slot, c', in a weighted lever-arm, C', one end of which turns on an axis, c, carried by the standard A^1, while its opposite end rests on an enlargement or cam surface, d, formed or affixed to the end of a lever-arm, D, pivoted in the upper end of the standard A^2. d^1 is a recess formed in the under side of the lever-arm C, for the reception of a friction pulley, d^2, for the purpose of lessening the friction between the arm C and the enlargement d. E is a retaining pawl or lever, the upper end of which engages with the rack, b^5, of the lifting-bar B. The pawls or levers, C and E, are retained in contact with the teeth of the bar B by means of springs, F, except when the said pawls or levers are withdrawn by pressing the foot on the treadle g of a lever, G, the arm g^1 of which is connected to the pawl E by means of a chain or connection, g^2.

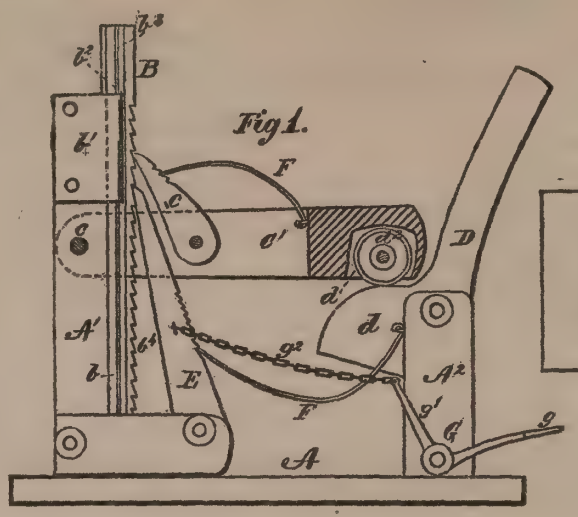


Fig. 1.

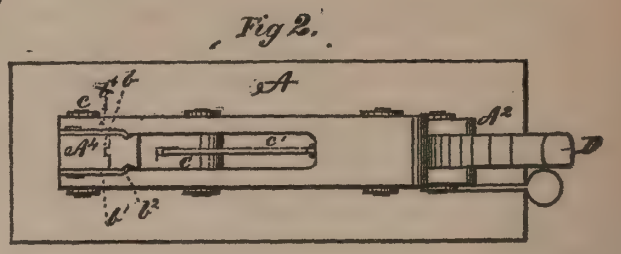


Fig. 2.

The operation of the device is as follows: The lever D being in the position shown by Fig. 1, it is simply necessary (after placing the lifting-bar B under the load to be raised) to depress the lever-arm D, thereby causing its enlargement d to raise the end of the lever C, thereby forcing the lever C upward, and raising the bar B one or more notches. The lever-arm D is then raised to the position shown by Fig. 1, and the operation repeated until the bar B has been raised to the desired height, where it will be retained by the lever E until released by the withdrawal of the levers C E from contact with the teeth b^4."

HATS AND HAT-MAKING.

The vast improvements that modern invention has produced are nowhere made more manifest than in the fabrication of hats. So greatly has this industry been advanced during late years that an extensive treatise on the subject is fully warranted.

By the former process of forming hat bodies, slivers of wool were taken from the duffer of a carding-machine and wound upon a cone in different directions, by which means a felting was produced. This process has been altogether superseded by the machine in present use, which effects an even deposit of hair upon the cone by means of a rotary blower or a brush. The first machine embracing these principles was invented by H. A. Wells in 1848, but since that time many improvements and modifications have been added.

Any kind of fur can be used for the purpose, but wool gives very unsatisfactory results. After passing through a picking-machine similar to that used for shoddy, which separates the hairs, the fur is supplied to the machine (Fig. 1, reproduced

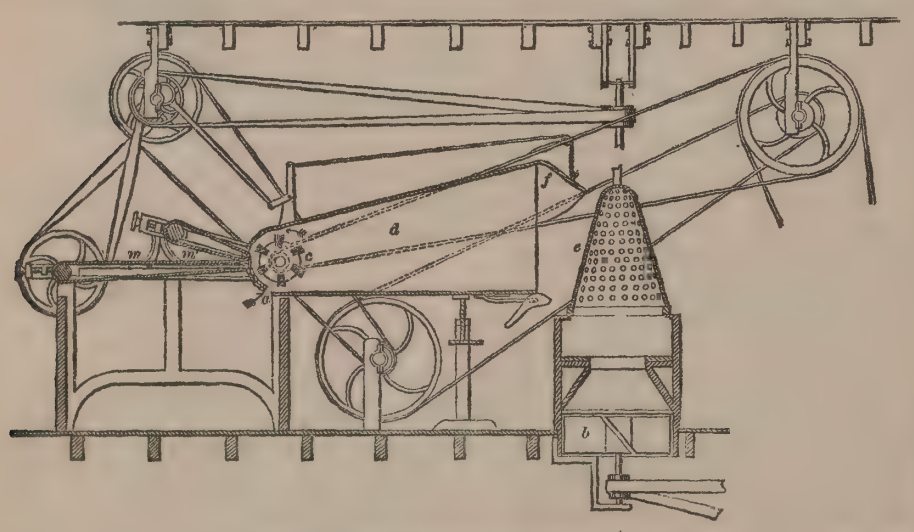


Fig. 1.—Body-Forming Machine.

from *Knight's Mechanical Dictionary*) between the feeding-belts mm', and by means of the rotating brush c is blown along the tunnel d, air being drawn through the aperture a by the fan-blower b. Before the tunnel is brought a revolving perforated cone, e, upon which the fur is deposited and held by exhausting the air with the fan b. By means of the hinged deflector f, the discharge of fur from the tunnel can be regulated, so that an increased thickness may be given to the lower part of the hat body.

When all of the given weight of fur that is to compose the hat has been deposited on the form, a metallic cover is placed over it, and it is submerged in a hot-water bath, to which a little sulphuric acid is generally added to contract the material and make the felting more complete.

After the hat bodies have been formed in this manner, they are next conveyed to the fulling-machine, the duty of which is to thicken and consolidate the body. Fig. 2 is the one in general use. It consists of several beaters successively raised and dropped upon the hats contained in the trough, which are turned and agitated by mechanical means. Fig. 3 shows a more modern and a much more effectual machine. The body is placed in the mould D and the cone or forming-block G brought over it. Through the perforations in the mould, and also through the *former*, steam is admitted. The mould is made to rotate one way and the former the other, although it also has an up-and-down motion. The curved lapping surfaces serve to crowd down the body and aid in fulling the *bat*. By means of a weight outward upon the beam-lever, a blow of constantly-increasing weight is given to the cone G as the work proceeds. A is the steam-chamber, and B the live-steam pipe.

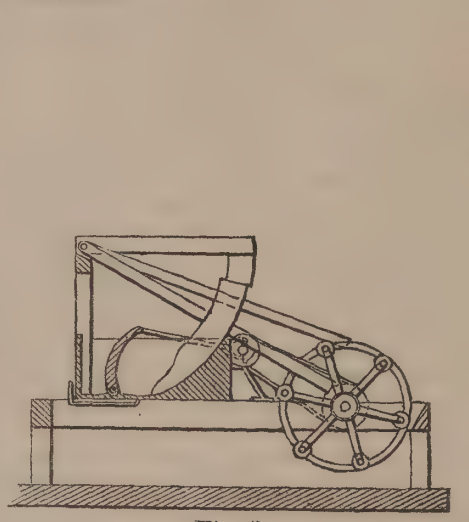


Fig. 2.

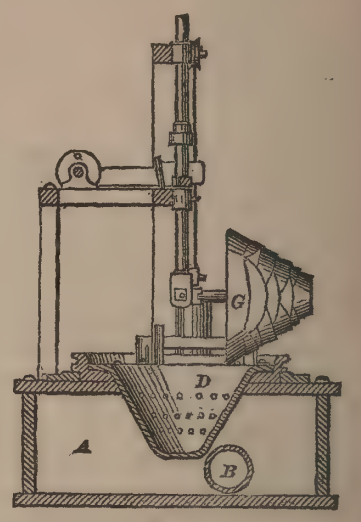


Fig. 3.

Fulling Machines.

Fig. 4.—Hat Makers' Battery.

Fig. 4 represents the hat-makers' battery. It consists of a boiler surrounded by tables to accommodate a number of workmen. At this battery the hat bodies are covered by the fur *napping*, each previously prepared, so that the latter forms a fur covering for the former. This is accomplished by drawing the sheet of napping over the hat body, by sprinkling mild sulphuric-acid water over them from time to time, and by rubbing, pressing and rolling with a pin until the butt-ends of the filaments are driven into the interstices between the fibres of the body.

In subsequent articles we shall treat of moulding, pouncing, pressing, stretching, blocking and weaving-machines.

H. T. W.

SHEET BRASS AND BRASS WIRE.

The manifold uses for which sheet brass and brass wire are employed render the manufacture of these compositions an important one. It is also one of great extent, the annual production in this country being not less than twenty million pounds. There are three kinds of marketable brass—sheathing metal, sheet brass, and cast brass, beside brass wire—each having a different composition, or differing proportions of the metals, and requiring a different treatment in manufacture. Lead is used in the composition of brass only for special purposes, the sheet brass being composed entirely of copper and spelter—zinc. The copper comes from the Lake Superior mines, and the zinc from New Jersey, Pennsylvania and Missouri. For sheet or "manufacturers'" brass the pure copper and cast zinc, known technically as spelter, are melted in plumbago crucibles in amounts varying not far from one hundred pounds. The melted metal is covered with powdered charcoal to prevent oxidation, and is poured into cast iron moulds, forming the metal into slabs of varying width and length, according to the after purposes of the material. In rolling, the metal expands but little

transversely, so that a casting designed to produce a sheet five inches wide is usually cast to four and a half inches in width. To make the brass into sheets, only rolling and annealing are required, but these must alternate and be frequently repeated. Ovens, called muffles, twenty-five feet deep and six feet wide, are required for the annealing. They are heated by wood, as preferable to coal, leaving the surface of the metal cleaner. At first the straight bars of brass are put in, but as these grow into plates and sheets they are rolled in coils to be heated. When red hot they are put into a weak pickle to clean as well as to soften them. There are other impurities beside those of oxidation that show themselves as the work of rolling progresses, impurities which were in the melted metal. These must be removed by hand scraping or by a machine scraper, and this is done at a stage in the rolling when the metal is approaching the requisite finish and thinness. Unlike iron, brass is rolled when cold. The sheets are gauged very close by the set of the rolls, but are sorted and tested by the ordinary wire gauge. The imperfect ends of the sheets and their jagged sides are trimmed by rotary shears, when the sheets receive their final cleaning. After being pickled the sheets are passed through a bath of sawdust, between revolving brushes, on to a mandril that rolls the sheet into a close coil, which is bound with wire and is ready for the market.

For making wire the castings are made into slabs of over seven feet in length. These are rolled into plates, passed through cutters that slit them into rods, and then run through grooved rolls that give them a rough cylindrical shape. Then comes the drawing, precisely like any wire drawing, the dies being of hardened steel with holes having a large inlet and a contracted outlet. Repeated drawings and annealings comprise the processes of wire making, the finished material ranging in size through the entire limit of the gauge, and sometimes special sizes being made, wire of extreme tenuity being required for particular purposes. It is made for a certain quality of imitation gilt braid, of such fineness that the flattened wire is spun around cotton thread, entirely covering it, and yet this brass-covered thread forms one not larger than the common coarse cotton used by the seamstress. J. H. L.

STEAM JACKETS.

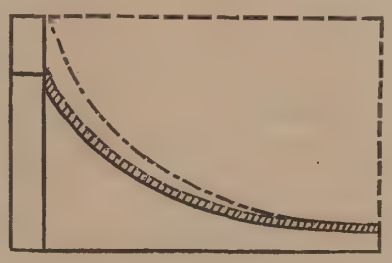
Watt was the first to use the steam jacket, but for a long time its action was but improperly understood, and many engineers considered it an expensive and useless refinement. Nevertheless, with the increasing application of high pressure and greater rates of expansion, all those designers that aimed at the most perfect and economical performance of the steam engine, found it necessary to apply the steam jacket.

The object of the steam jacket is primarily to prevent, as much as possible, a liquefaction of steam in the cylinder of an engine working expansively, by keeping the metal of the cylinder at a uniform temperature. After the steam is cut off, heat is abstracted from the expanding steam in proportion to the work performed, and a part of the steam is liquefied.

Towards the end of the stroke the pressure and temperature of the expanding steam having fallen considerably, this water is evaporated again, abstracting the heat from the metal of the cylinder and piston. If there is no steam jacket, these parts have to be heated again by the incoming fresh steam, and a considerable fall of initial pressure is the result. This effect can be seen on any indicator card; by drawing on it a theoretical expansion curve, the actual curve will be inside the theoretical card during the first part of the expansion, while towards the end it will come up to it and may even rise above it.

A steam jacket, containing steam of initial pressure and temperature, will (to a great extent at least) prevent liquefaction, by supplying the expanding steam with the heat lost in the performance of work; even if some steam is condensed and evaporated towards the end, the cooling of the metal of the cylinder will not take place, as its loss of heat is immediately supplied by the jacket. Consequently, when the fresh steam comes in, it loses but little of its efficiency.

The accompanying diagram will give a very good idea of the action of steam in an expansive engine. The upper curve would be obtained by the use of a steam jacket, while the lowest shows how the initial pressure is lowered, where there is no jacket the middle curve giving the effect of re-evaporation.



Of course a certain quantity of heat is lost by condensation in the jacket, but as the pressure there does not vary, and the condensed water is drained off, *it cannot pass back into the state of vapor, absorbing a great amount of heat*, as it would do in the cylinder; thus the heat lost in the jacket is not so great as it would be if the steam were condensed in the cylinder. But even supposing that the losses were equal, there would still be the advantage that the *power of the engine would be unimpaired.*

Sometimes the steam coming from the boiler has been passed through the jacket before entering the cylinder, but this arrangement is likely to defeat its object. The water condensed in the jacket would be held in suspension by the steam, enter the cylinder, and there effect all the mischief, which the jacket is destined to prevent. For this reason a special steam pipe should always supply the jacket, and the condensed water should always be drained off well; it may be mixed with the feedwater, and thus its heat is returned to the boiler.

Another incidental advantage of the jacket is that it keeps the cylinder at a uniform temperature, thus preventing any alteration in diameter, etc. This was curiously illustrated by Mr. Hawksley, at the last meeting of the Mechanical Engineers of England. He had bought a Cornish engine, whose high pressure cylinder was jacketed, and the low pressure cylinder was not. When the engine began to work, all seemed well; but in a short time the stroke began to diminish, and in 1½ hours the engine had lost 18 inches of its stroke. On examination he found that the difference of temperature at the two ends had given the low pressure cylinder a conical form, it being full ⅛ inch larger at the hottest end. J. HAUG, M. E.

Fig. 1.

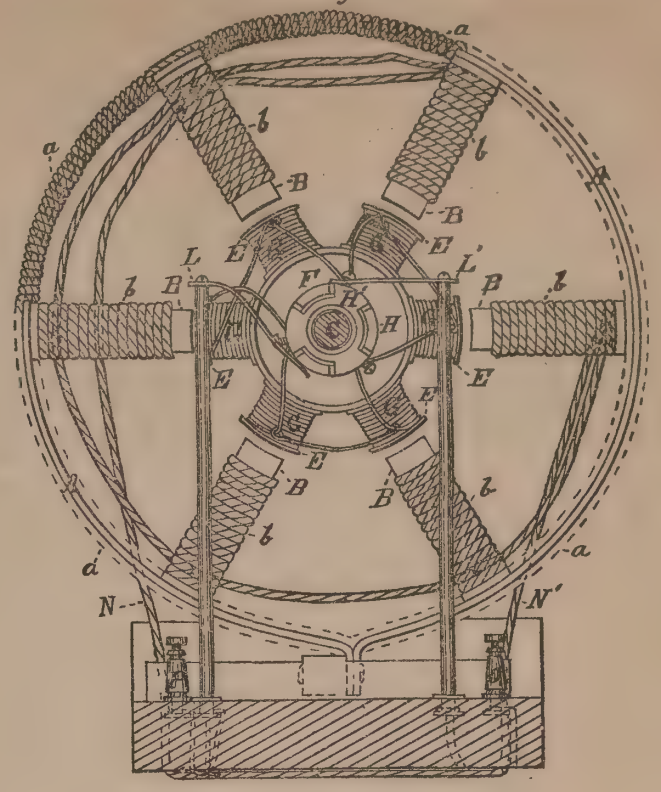


Fig. 2.

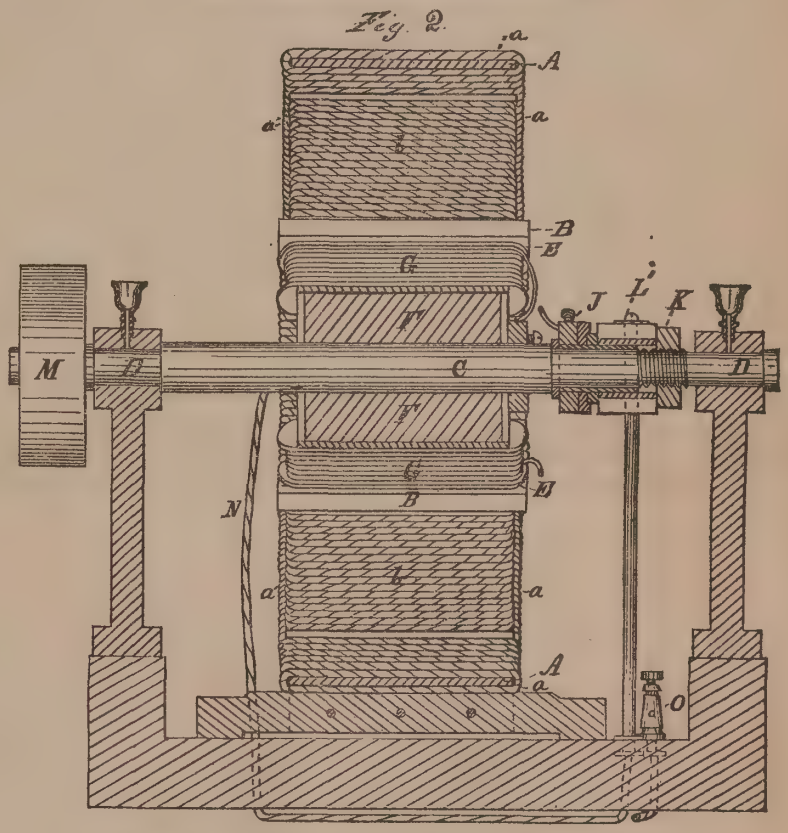


Fig. 4.

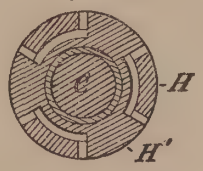
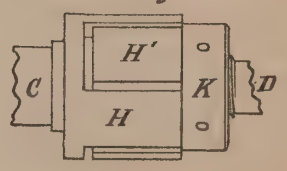


Fig. 3.



THE WESTON DYNAMO-ELECTRIC MACHINE.

An iron ring or cylinder, *A*, forming the outside of the machine, is supported or attached to a wooden base. From the interior of this ring or cylinder a number of radially projecting magnets, *BBBB*, are arranged, all pointing to a common centre. The magnets consist of a core of iron, to which are fastened a number of thin tempered steel plates, and they are wrapped with copper wire, *bbbb*, insulated in any suitable way, in the manner usually employed in making electro-magnets. The magnets are so connected together that the poles will be alternately north and south.

In the central space left between the inward ends of these magnets a shaft, *C*, is arranged, carried by bearings, *DD*, Fig. 2, which, in order to secure strength and perfect alignment, are fitted and firmly secured into a slot on the side of the ring. A series of armatures, *EEEE*, made in segments, are firmly secured to the shaft, *C*, by two nuts, one at each end. By turning these nuts the armatures are made to bind very tightly on the shaft. These armatures are of iron, and are also wrapped with wire, *GGGG*. The outwardly projecting ends, *EE*, are thin *lozenge-shaped* pieces of iron, and so arranged that when they are simultaneously revolved, by the turning of the shaft, the outwardly projecting ends will pass closely, but without touching the inwardly projecting ends of the magnets, *BBBB*.

When the shaft, *C*, is revolved, carrying the armatures, *G*, very rapidly past the electro-magnets, *B* (which have been previously charged), currents of electricity will

be induced in the wires surrounding the armatures; but as such currents are constantly changing their direction, a device called a "commutator" has to be used.

The commutator used on this machine is peculiarly simple; it consists of only two pieces, *H* and *H'*, and requires but two springs to carry the currents from all the armatures. One part, *H*, is slipped upon the shaft, *C*, but is insulated from it and from the other part, *H'*, of the commutator, both parts revolving with the shaft upon which they are mounted.

A thimble of wood is slipped upon the shaft, and upon this thimble a brass washer, *J*, is placed, to which the wires proceeding from the armatures through a hardened steel bushing containing wooden tubes are fastened. The one half of the commutator slips over the shaft and rests upon the thimble, and is pressed against this brass washer; the other half of the commutator slips upon the shaft, but there is placed between the two halves a thin wooden or rubber washer so as to insulate them from each other. The other ends of the wires from the armatures are connected to the shaft, and through the shaft to that half of the commutator which bears upon it. A nut, *K*, is used to keep the two parts of the commutator together, and upon the shaft.

Two springs or brushes, *L* and *L'*, are used with this commutator, which are made of very thin, hard-rolled sheet copper, silver plated, in order to secure good contact without much friction. The object of silver plating them is to prevent oxidation of the separate strips, and so ensure a connection between the whole. These springs are fixed in adjustable clamps supported on brass pillars. These clamps are conveniently arranged, so that they can be taken out, cleaned, and replaced in a very short time, and at the same time give the operator full scope for removing, cleaning, and replacing the commutator.

The operation of the machine is as follows: When the apparatus is first made, the electro-magnets are for a moment connected to a battery or other source of electricity, which charges the steel plates and renders them permanently magnetic. Now, if a belt from any source of power be put on the pulley, *M*, and the armatures are set in motion, weak currents will be induced in the wires surrounding the armatures, which are picked up by the springs, *LL*, and carried to the two pillars. If the two wires, *NN'*, leading from the coils of the electro-magnets, be placed in contact with these pillars, the weak currents from the armatures will pass around the electro-magnets and will strengthen them; this will again increase the strength of the currents induced in the armatures, and so on, until a maximum is reached. To utilize the currents from such a machine, it would be simply necessary to place the work to be done in circuit with the electro-magnets and armatures; so that the currents induced in the armatures may pass through that circuit, and through the coils of the electro-magnets.

But such a machine would have very limited applications; it could not be used for electro-plating, electrotyping, and the other purposes of electro-metallurgy; as the currents resulting from the "polarization" of the electrodes in the vat would, when the speed of the machine fell below a certain point, reverse the polarity of the electro-magnets and the direction of the current; undoing what it had previously done, and spoiling the work.

In order to prevent this, a device is used on this machine which is very simple, perfectly automatic, and accomplishes the purpose admirably. A pillar of brass, iron or other good conducting material is fixed on the base of the machine (Fig. 5), on the top

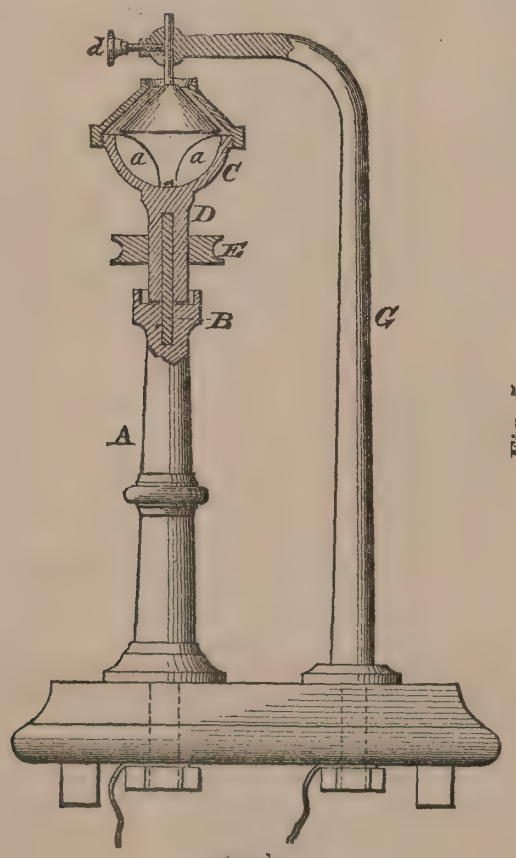


Fig. 5.

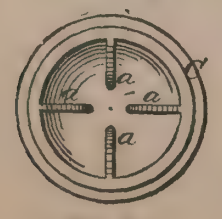


Fig. 6.

of which a cup containing mercury is made to rotate by means of a belt running from the shaft of the machine. This cup has ribs or paddles on the inner side of the lower half, *aa*, Fig. 6. At a little distance from this pillar another is placed, standing vertically and parallel with the other, but the upper end of this pillar is bent at a right angle, so as to project a little way over the centre of and above the cup containing the mercury. A hole is drilled near the end of this pillar in a line with the cup, and through this hole a wire is passed. Another hole is drilled at right angles to this one, and tapped, and a small set screw is inserted to hold the wire at any given height.

This wire is cleaned and amalgamated with mercury, and a small quantity of mercury is poured into the cup. The wire is then adjusted so that it touches the mercury in the cup. It is evident that as long as the cup remains stationary the mercury will remain at the bottom, and the wire and cup will be in metallic connection; but if the cup be rotated at a certain speed, the mercury will rise in the cup, and the connection between the wire and the cup be broken.

Supposing now that the two wires from the machine are connected with this apparatus, one wire to each pillar, and the machine started, the current will flow up the pillar through the mercury, up the pin and down the pillar to the other wire, and back again to the machine, thus completing the circuit; in fact the circuit would be closed. But suppose the cup containing the mercury was also caused to rotate by means of a belt running from the shaft of the machine, then it is obvious that, when the machine, and consequently the cup, has reached a certain speed, the connection would be broken, the circuit would be opened, and the current could flow through an outside conductor if it was connected to the two pillars.

Conversely, when the machine, and consequently the cup, falls to a certain speed, the connection between the cup and pin would again be completed, and the current would cease to flow into the external conductor, such as an electro-plating vat. It is plain, therefore, that the reverse current could not flow through the coils of the electro-magnets, but would flow through the mercury and would soon be exhausted.

By a slight modification this machine may be made to close the circuit between the vats and the machine when the machine reaches a certain speed, and break it again when it falls below that speed. I prefer to do this in the case of large machines, which, when they are on closed circuit with small resistance, require considerable power to start them, and there is great danger of the belt running off before they reach the speed necessary to open the circuit and break the connection by the mercury rising and leaving the pin. In this case it is necessary to use a wire with a disc of metal slightly smaller than the largest point of the inside of the cup, *C*, so that when the cup revolves and the mercury rises it will touch the disc, and when it falls again the connection will be broken. In order to use this arrangement it is necessary to connect one of the wires proceeding from the machine to one of the pillars, and the other pillar is to be connected to a binding-post to which a wire, leading from one of the electrodes of a vat, may be attached. The other wire from the machine is connected directly to the other electrode in the vat, or, more conveniently, to a binding-post on the base of the machine, to which a wire may be attached at any time. With this arrangement the circuit between the machine and the vat is not closed until the machine reaches a certain speed, which can be varied by raising or lowering the disc, and the connection is again broken before the machine falls below a certain speed, thus preventing the reverse currents from the vat passing around the electro-magnets and changing their polarity.

Proper binding-posts, *O*, *P*, are placed upon the base, to which wires may be attached, and the current carried to any desired point.

The most noteworthy advantages claimed for this machine are the following:

The use of an iron ring or shell to which all the magnets are attached

One circuit and one shaft only is used; dispensing with the use of extra commutators and brushes.

The currents from *all* the armatures are picked up by *two brushes* and sent round the electro-magnets.

The armatures are constructed *entirely* of iron. The commutator is made in a very simple manner, and has only two pieces. The commutator is *outside* the bearings, while in all other machines it has been put inside.

The parts liable to be injured by dirt and oil are thoroughly protected by the nickel-plated cover.

It is the only dynamo-electric machine which has an automatic switch.

The parts subject to wear are interchangeable, and can be replaced in a few minutes.

It is about half the size and weight of any other machine of equal power.

The ring uniting all the electro-magnets secures an equalization of the magnetic field, and balances the strains upon the armatures and shaft; thus reducing the wear and tear of the machine

The use of one circuit is a very important matter, since it not only saves much power, wear on the machine, the use of *two* commutators and four brushes, besides much injury to the same, but also secures an almost perfect self-regulating machine—the current generated depending upon the surface of the work in the solutions. This is of much importance in electro-plating and electrotyping, as it saves the operator much time, besides relieving him from any danger of spoiling his work by use of too strong a current.

The armatures being constructed entirely of iron, there should be no danger of their getting out of true and striking the electro-magnets, which in other machines gives rise to such costly repairs, as well as much annoyance.

The commutator being placed outside the bearings, it is not necessary to remove the bearings in order to clean it; saving much time, and making it much easier to adjust the brushes and commutator.

The use of the lozenge-shaped plates on the armatures saves power, and avoids the severe strain and injury to the machine from the too sudden cutting of the lines of force, besides making the machine almost noiseless.

The steel plates prevent the current from the vats reversing the direction of the current *while the machine is running*—a difficulty which gave rise to much trouble in other machines, and rendered them perfectly useless.

It is affirmed to be nearly three times as powerful as any other machine of its size and weight, and the smallest machine that has ever been used to do electro-plating, while requiring less power to run it than any machine of the kind invented, and may be run at from 450 to 800 revolutions per minute.

It has been the aim of the inventor of this machine to secure a simple, reliable, compact, cheap, powerful machine, which should require but little care and attention and a minimum cost for repairs, and which should be so easily managed that he could, after a few minutes' instruction, with confidence leave it in the hands of the most ignorant to be used as a source of electricity for any purpose.

That he has succeeded will be inferred by the statement that over one hundred machines have been sold in about eight months, and that the demand is continually increasing.

POPULAR FALLACIES.

Night air and damp weather are held in great horror by multitudes of persons who are sickly or of weak constitutions; consequently, by avoiding the night air, and damp weather, and changeable weather, and weather that is considered too hot or too cold, they are kept within doors the much largest portion of their time, and as a matter of course continue invalids, more and more ripening for the grave every hour. The reason is, they are breathing an impure atmosphere nineteen-twentieths of their whole existence.

As nothing can wash us clean but pure water, so nothing can cleanse the blood, nothing can make health-giving blood, but the agency of pure air. So great is the tendency of the blood to become impure in consequence of waste and useless matters mixing with it as it passes through the body, that it requires a hogshead of air every hour of our lives to unload it of these impurities; but in proportion as this air is vitiated, in such proportion does it infallibly fail to relieve the blood of these impurities; and impure blood is the foundation of all disease. The great fact that those who are out of doors most, summer and winter, day and night, rain or shine, have the best health the world over, does of itself falsify the general impression that night air or any other out-door air is unhealthy as compared with in-door air at the same time.

Air is the great necessity of life—so much so that, if deprived of it for a moment, we perish; and so constant is the necessity of the blood for contact with the atmosphere, that every drop in the body is exposed to the air through the medium of the lungs every two minutes and a half of our existence.

Whatever may be the impurity of the out-door air of any locality, the in-door air of that locality is still more impure, because of the dust and decaying and odoriferous matters which are found in all dwellings. Besides, how can in-door air be more healthy than the out-door air, other things being equal, when the dwelling is supplied with air from without?

To this very general law there is one exception, which it is of the highest importance to note. When the days are hot and the nights cool, there are periods of time within each twenty-four hours when it is safest to be in-doors, with doors and windows closed—that is to say, for the hour or two including sunrise and sunset—because about sunset the air cools, and the vapors which the heats of the day have caused to ascend far above us condense and settle near the surface of the earth, so as to be breathed by the inhabitants. As the night grows colder these vapors sink lower, and are within a foot or two of the earth, so they are not breathed. As the sun rises these same vapors are warmed and begin to ascend, to be breathed again; but as the air becomes warmer, they are carried so far above our heads as to become innocuous. Thus it is that the old citizens of Charleston, S. C., remember that, while it was considered important to live in the country during the summer, the common observation of the people originated the custom of riding into town, not in the cool of the evening or of the morning, but in the middle of the day. They did not understand the philosophy, but they observed the fact that those who came to the city at midday remained well, while those who did so early or late suffered from it.

All strangers at Rome are cautioned not to cross the Pontine marshes after the heat of the day is over. Sixteen of a ship's crew touching at one of the West India islands slept on shore several nights, and thirteen of them died of yellow fever in a few days; while of two hundred and eighty who were freely ashore during the day, not a single case of illness occurred. The marshes above named are crossed in six or eight hours, and many travelers who do it in the night are attacked with mortal fevers. This does at first sight seem to indicate that night air *is* unwholesome, at least in the locality of virulent malarias; but there is no direct proof that the air about sunrise and sunset is not that which is productive of the mischief.

For the sake of eliciting the observations of intelligent men, we present our theory on this subject.

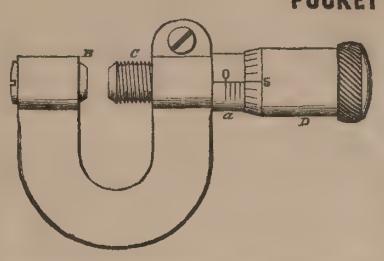
A person might cross these marshes with impunity who would set out on his journey an hour or two after sundown, and finish it an hour or two before sun-up, especially if he began that journey on a hearty meal, because in this way he would be traveling in the cool of the night, which coolness keeps the malaria so near the surface of the earth as to prevent its being breathed to a hurtful extent.

But if it is deadly to sleep out of doors all night in a malarial locality, would it be necessarily fatal to sleep in a house in such a locality? It would not. It would be safer to sleep in the house, especially if the windows and doors were closed. The reason is that the house has been warmed during the day, and if kept closed it remains much warmer during the night in-doors than it is out-doors; consequently, the malaria is kept by this warmth so high above the head and so rarefied as to be comparatively harmless. This may seem to some too nice a distinction altogether; but it will be found throughout the world of nature that the works of the Almighty are most strikingly beautiful in their minutiæ, and these minutiæ are the foundation of his mightiest manifestations.

Thus it is, too, that what we call fever and ague might be banished from the country as a general disease, if two things were done:—1. Have a fire kindled every morning at daylight, from spring to fall, in the family room, to which all the family should repair from their chambers, and there remain until breakfast is taken. 2. Let a fire be kindled in the family room a short time before sundown; let every member of the family repair to it, and there remain until supper is taken.

In both cases the philosophy of the course marked out consists in two things:—First. The fire rarefies the malaria and causes it to ascend above the breathing-point. Second. The food taken into the stomach creates an activity of circulation which repels disease.—*Hall's Journal of Health.*

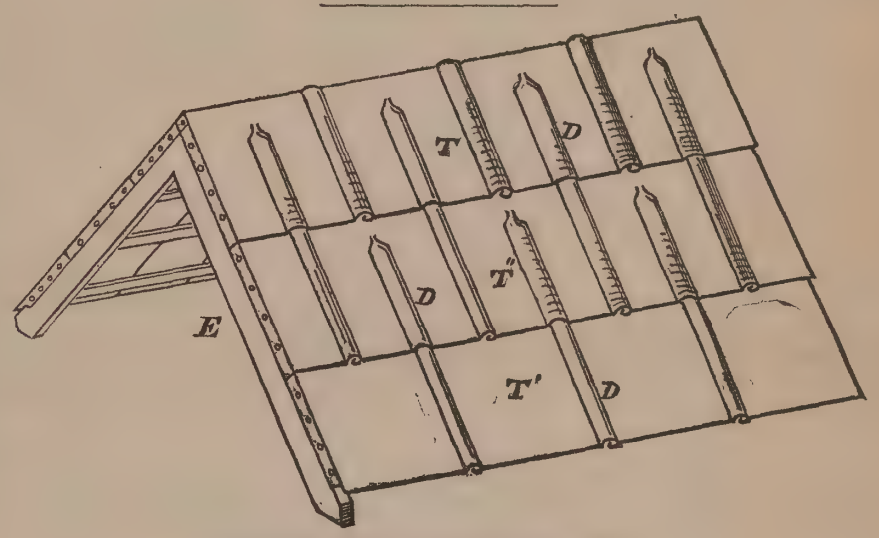
POCKET MICROMETER GAUGE.



The cut shows in actual size a "thousandth gauge" or micrometer caliper, which as made is a reliable and convenient substitute for the Vernier caliper for measurements less than an inch. The bow has a projecting shank, *a*, bearing the screw, *C*, and having marked upon it graduations of the same pitch (40 to the inch.) The hollow cap, *D*, being the head of the screw, fits outside the shank, *a*, and has on the circumference of its beveled end, graduated into 25ths of the circle. One revolution of the screw, *C*, causes the head, *D*, to advance $\frac{1}{40} = \frac{25}{1000}$ upon the shank, *a*, as shown by its lengthwise graduations; $\frac{1}{25}$ revolution of the screw (as registered by the peripheral graduations on *D*) causes the screw to advance $\frac{1}{25 \times 40} = \frac{1}{1000}$. It may be seen that half or quarter graduations may be read without much trouble, showing two-thousandths or four-thousandths. (A Vernier circle on the shank and on the head would really permit of reading ten-thousandths, although it is questionable whether the accuracy of even this delicate screw would enable such fine contacts.) *B* is the abutment, which is adjustable by means of the screw shown at the left, although both it and the screw end are hardened. The clamp screw at the right of the bow holds the screw at any desired position. The bow is less likely to be sprung than the English or square cornered form.

The makers are the Brown & Sharpe Manufacturing Company, Providence, R. I.

G.



IMPROVEMENT IN METAL SHINGLES.

"The object of this invention is a metallic shingle which is durable, comparatively light, and can be cheaply and easily manufactured and applied. The engraving is a perspective view, showing a roof constructed with these shingles.

The shingle consists of a metal plate, *T*, having at one or both edges ribs, *a c*. *B* represents a small tag with a rib which fits over a corresponding rib of the plate *T*, as hereafter described. *D* is a raised rib midway between the ribs *a c* of the plate *T*. The ribs *A* are formed by bending the edges of the plates to curl upwards, and the ribs *C* by bending the edges downwards, and these ribs *C* are made slightly larger than the ribs *A*, so that the latter may slide easily and fit snugly into the larger ribs *C*. The rib of the tag *B* slides over the smaller rib *A*, and the flat part is nailed down to the roof or rafters and prevents the slipping of the plates. The shingle *T'*, intended for the bottom of the roof or lower course, need have no central rib *D*, and the side shingle *T''* need have but one rib, the opposite side being plain so as to facilitate bending it down and nailing to the edge of the roof.

The shingles *T''* are placed on the lower course, the smaller hollow rib *A* of each shingle being slipped into the larger rib *C* of the next shingle. In applying the next course, the side half shingle *T''* is first secured, and then the shingles *T* successively in the same manner as the first row, the hollow ribs *D* receiving the ribs of the course below, so that the joints of the shingles in each row are midway between those of the other rows, permitting the desirable alternate arrangement common with ordinary shingles.

It is claimed that this shingle is easily made, simple in construction, only three different forms being required in making a roof; and that the roof-covering is watertight, ornamental, and easily applied and removed."

[Patented April 3d, 1877, by Edward Locher and Christian Knispel, of Newark, New Jersey.]

THE ABSTRACTION OF GOLD FROM PHOTOGRAPHERS' WASTE.—Herr F. Haugk filters the old gold baths into a glass flask (white) and adds an excess of carbonate of soda, and then adds an alcoholic solution of aniline red, drop after drop, till the liquid is of a raspberry red color. If the liquid be now exposed to the sunlight, the gold will precipitate itself in the course of six or eight hours. After a sufficient quantity of gold has been precipitated in this manner, the superimposed liquid is poured off, the residue washed, brought on a filter and incinerated, and there dissolved in aqua regia. Upon evaporating the resulting solution to dryness, the gold is obtained as a chloride, and can at once be again put in use for photographic purposes.—*Photographischen Archiv. per D. Al. Polytech. Ztg.*, v, 375.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

VII.

IRREGULARITIES OF THE CRANK MOTION.

The relation between the movement of the piston and that of the crank-shaft is in fact somewhat different from that considered in the preceding pages. When the crank is at right angles (see Fig. 18) the piston is not in the middle of its

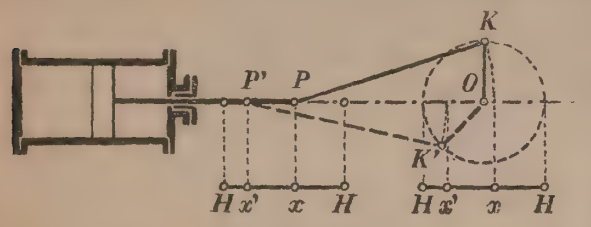

Fig. 18.

stroke but is nearer to the crank-shaft, on account of the obliquity of the connecting-rod. At any other crank-angle the obliquity of the connecting-rod will likewise affect the position of the piston, though to a less extent, the nearer the crank approaches either of its dead centres.

A circular arc swept from the crosshead end of the connecting-rod through the crank-pin circle will intersect the horizontal diameter of the crank circle in a point having the same relation to this diameter as the position of the piston has to its stroke. If it is required to find the true position of the piston for a given crank-angle, instead of projecting the crank-pin vertically, we should project it upon the horizontal diameter by a circular arc; and when the position of the piston is known the corresponding crank-angle can be found in the same way. The radius of this projection-arc should be equal to the length of the connecting-rod, measured on the same scale to which the crank-pin circle is drawn, and its centre should be located on the line of movement of the crosshead.

These variations from the previously considered ideal movement of the piston will evidently gain in extent as the connecting-rod is shortened, and the latter should, for this as for other reasons, rarely be made shorter than $4\frac{1}{2}$ times the length of the crank. On horizontal engines it is usually equal to 5 times the crank.

It will now be understood that the piston runs ahead of its ideal movement on its "forward stroke" (that is when the connecting-rod is strained on compression,) and stays behind the same during its return stroke. The result will be the admission of more steam on the fore-stroke than on the return-stroke, and hence an unequal development of work at both strokes. This difference will be augmented by the presence of the piston-rod, which diminishes the active surface of one side of the piston, except where an extension of the piston-rod passes through a stuffing box on the back head of the cylinder.

The movement of the valve, in its relation to that of the crank-shaft, is subject to similar inequalities, owing to the oscillations of the eccentric-rod, and the valve will be drawn more or less towards the crank-shaft. However, as the eccentric-rod is generally very long in relation to the throw of the eccentric, these variations are small, and besides their effect can easily be neutralized by slightly lengthening the valve stem, which measure will cause the greatest port opening at the fore-stroke to be a trifle less than that of the return-stroke. This correction is achieved by the practice of setting the valve by the lead, or, in other words, by adjusting the valve stem while the eccentric-rod is in an inclined position.

The inequality of the cut-off, occasioned by the obliquity of the connecting-rod, can be rectified by giving the valve a different lap for each of the two ports, but this rectification is attained at the expense of an equal lead, and is therefore seldom taken advantage of in practice.

An equalization of the compression can be effected by following the same course respecting the inside-lap.

On engines that are provided with valves having equal lap on both sides, a rectification of the point of cut-off can be accomplished by lengthening the valve-stem. This operation is equivalent to an enlargement of the laps relating to a positive movement of the valve and a diminution of those relating to a negative movement; it will therefore destroy the equality of lead, and it will more than rectify release and cushioning. In this case the neutral position of the valve is no more a central one, but is as shown in Fig. 19 where the

Fig. 19.

laps ab, and $c'd'$ exceed the laps $a'b'$ and cd, the former pertaining to a positive, the latter to a negative movement.

Problem V. It is required to find the exact positions of the piston for the cutting off, the release and the cushioning of the engine considered in Problem I., if the connecting-rod is 16″ long.

The diagram can be constructed as shown before, but instead of drawing vertical projection-lines from the crank-pin centres E, C, and R, circular projection-lines are to be used, of a radius equal to 16″, measured, however, on the scale to which the crank-pin circle has been drawn. The resulting points can now easily be transferred upon two separate lines, for the fore and the return stroke, as shown in Fig. 20.

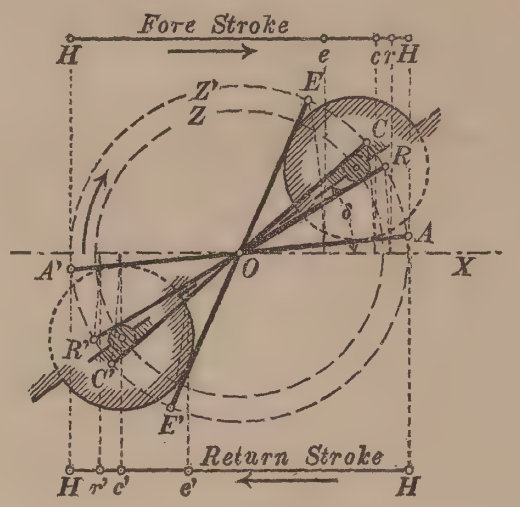

Fig. 20.

A comparison between the fore and the return-stroke will be easier if the lower half of the diagram is drawn in combination with the upper half (see Fig. 21). This form of the

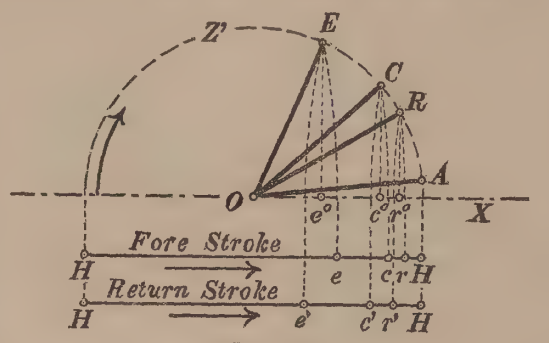

Fig. 21.

diagram shows very plainly the amount of the variation, as compared with the results of our first method of projecting by vertical lines.

Problem VI.—The case of Problem II. is to be solved for equalized cut-off and equalized compression, if the connecting rod is 45″ long and the lead for the fore stroke $\frac{1}{32}$″. The solution of this problem involves the drawing of two distinct diagrams, one resembling Fig. 5, the other Fig. 6, both differing by their lap-circles, since the lap for both sorts will differ. Both diagrams can, however, readily be drawn in one figure.

We draw in Fig. 22 the crank circle Z, as we did in Fig.

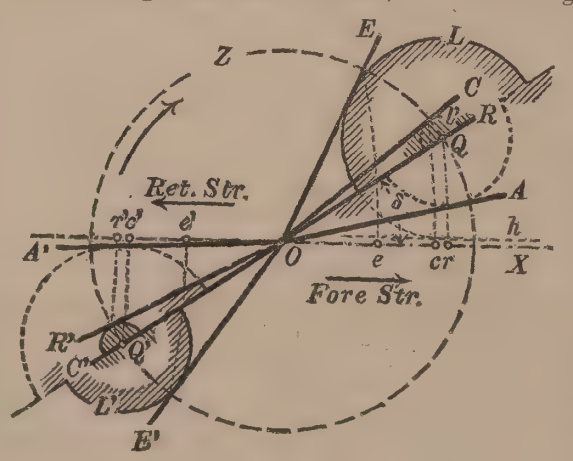

Fig. 22.

14, and mark on the horizontal diameter the points e' and e for the cutting off and c and c' for the compression. The crank-angles E, E', C, and C' are then found by sweeping the projection arcs of the proper radius, and it will be seen that the corresponding crank-angles for both strokes are no longer diametrically opposite. Since the lead for the fore stroke is given, the diagram for the fore stroke can be drawn by drawing the horizontal line h $\frac{1}{32}$″ above OX, and bisecting the angle formed between this line and the line OE, to obtain the point Q on the circle Z, which, it will be remembered, serves in this case for both crank path and eccentric path. By drawing a line from Q through O we find the point Q', which happens to coincide practically with the point C' in this case. Now we can draw the lap-circle L, in full line, from Q to touch OE, and its mate, in dotted line, from Q'; also the lap-circle L', from Q' to touch OE', and its mate from Q. Next we draw, in dotted line (relating to compression, on the exhaust side of the piston), the lap-circle l' from Q, and its mate from Q' in full line. The last lap-circle, from Q' tangent to OC, remains yet to be drawn, but its radius is zero. The diagram now shows the lead for the return stroke to considerably exceed that of the fore stroke, and due attention must be paid to this circumstance in adjusting the valve on the engine. In fact, herein lies the greatest practical difficulty in rectifying the cut-off as shown, since most engineers are used to the practice of setting the valve to equal lead, and this valve, when so adjusted, will distribute the steam to less advantage than if no rectification would have been attempted. In other respects there can be little objection to this measure; for, notwithstanding the considerable lead on one side, the space which the piston is compelled to travel against the steam after admission is but a very small fraction of the stroke. The crank angles and positions of the piston for the release may be found without difficulty in the diagram.

Those circles swept from Q in full lines represent the laps of that side of the valve that covers the port, S, (Fig. 1) while those swept in full lines from Q' give the laps for the other side of the valve. The inside lap of the steam passage, S, is zero.

Problem VII. The valve considered in problem V is to be rectified for the cut-off by lengthening the valve stem. How much has the valve stem to be lengthened, and what effect will this measure have upon the lead and the exhaust?

The eccentric-path, Z, the crank-path, Z', and the point, Q, can be copied from Fig. 20. The proposed lengthening of the valve stem will hasten the cutting off at the fore stroke and delay that of the return stroke, and the cutting off will take place at the intermediate piston position, e^o, (Fig. 21) obtained by a vertical projection.* After copying this point from Fig. 21, in Fig. 23 we can find the exact crank angles, E

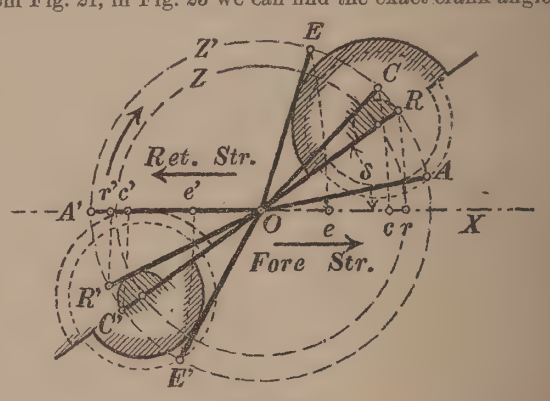

Fig. 23.

and E', by the projection arcs of the proper radius. The outside lap circles can then be swept, and their distance from the original lap circle equals the length by which the valve stem has to be lengthened, and which is found = about $\frac{1}{16}$″. The lead for the fore stroke will be zero, and that for the return stroke = $\frac{1}{8}$″.

In lengthening the valve stem by $\frac{1}{16}$″ the inside lap for the fore-stroke becomes $\frac{1}{16}$″ + $\frac{1}{16}$ = $\frac{1}{8}$″ and that for the return-stroke = $\frac{1}{16}$″ − $\frac{1}{16}$″ = 0. We can accordingly finish our diagram and determine the crank angles and piston-positions for cushioning and release, and a comparison of the resulting points c, c', r and r' with the corresponding points of Fig. 20 will show that the measure resulted in an over-correction of release and cushioning.

[*End of Part I.*]

Pivot Teeth in Dentistry.—Among the best of the inventions in the way of pivoting is a device of Dr. Bonwill's. The root being cut down, the pulp-canal is reamed out greatly in excess of the size of the pivot that is to occupy it. A pivot made of platinum wire, upon which a screw is cut, is next fitted into the canal, and firmly packed into place through the use of amalgam. When this amalgam is set, the tooth—the pivot hole running through it—is placed upon the pivot, and is screwed solidly into place by means of a delicate nut, made of gold. It will be understood, of course, that the fitting of the tooth in position has been done at the time of setting the pivot into the root. This operation, when well accomplished, holds a pivot tooth so firmly in place that it may be used with the utmost freedom in mastication.—*Scientific American*, xxxvii, 117.

*This last assertion is theoretically incorrect, for the point of cut-off, after the proper rectification will not precisely coincide with the point, e^o, but the difference is practically inappreciable.

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

A Canal is Proposed from Leesburg, on Lake Griffin, Sumter Co., Fla, to Panasolkaee Lake on the Withlockoochee River, which has its outlet in the Gulf of Mexico. It will be but 16 miles long and will connect the waters of the east and west coast of Florida so that steamers can cross from the unparalleled rich gulf hummock with the produce of that fertile region, and connect with steamers to New York. This short canal will open up 3000 square miles of the most fertile semi-tropical country in the world, which now has no outlet. —*Engineering*, iv, 220.

Whitehead Torpedo.—The German Admiralty is not satisfied with the Whitehead fish torpedo, as the slightest current was found capable of deflecting the missile in a manner that could not be calculated upon, even when the distance to be traversed was small.—*Eng. Mech.*, xxv, 533.

The Submarine Tunnel between Spain and Africa.—We notice in the *Messager du Midi* the following statistics relative to the prospected tunnel between Spain and Africa: "The Spanish engineers who are to undertake the work of the proposed international tunnel between Spain and Africa at the Strait of Gibraltar, have been here,—at Marseilles, several days. Their machines very much resemble those which are at present used at St. Gothard. The projected tunnel is to extend from within a short distance of Algisiras on the Spanish side to between Tanger and Centa on the African side. The length of the submarine tunnel will be nine miles, with an inclination of one foot per hundred. The approaches will have an extent of six or seven miles. The greatest depth of the sea is 3,000 feet. A thickness of 300 feet of rock will be left between the roof of the tunnel and the sea bottom, making the greatest depth of the tunnel 3300 feet below the level of the sea. The cost is estimated at four million pounds sterling. By means of this tunnel and the one between Dover and Calais, travellers will be enabled to go from England to Africa by land.—*Moniteur Industriel Belge*, iv, 355.

The Oroya Railroad in Peru is the subject of an interesting sketch lately published in *Scribner's Monthly*. It passes through a section in which nature is so prodigal of her products that the annual waste is enough to feed the population of China. It starts from the shores of the Pacific, at Callao, the port of Lima and chief seaport of Peru. Ascending gradually the Rimac, it crosses the summit of the Andes through a tunnel at the height of 15,645 feet above the sea. It then descends the valley of the Rio Yauli, a feeder of the Amazon, to Oroya, where terminates the first part of the great road which has been proposed to connect the waters of the Pacific and the Amazon. The highest railroad bridge in the world is on this road. The rolling stock and cross-ties have been been brought from the United States. Mr. Henry Meigs is the contractor, and the principal officers are Americans. The achievements accomplished in the building of this road places it in the first rank of modern engineering.

A New Machine has been devised which crushes the gold ore so fine that shaking and blowing separate the metal from the powdered stone. People from the gold districts are examining its capabilities.

Record of New Railroad Construction.—The *Railroad Gazette* for August 24th has information of the laying of track on new railroads as follows:

Syracuse Geneva & Corning.—Extended from Beaver Dam, N. Y., north to Watkins Glen, 6 miles.

Waynesburg & Washington.—The first track is laid from Washington, Pa., south to Baneville, 10 miles. It is of 3 ft. gauge.

Minneapolis & St. Louis.—Extended from Sioux City Junction, Minn., south to Waterville, 38 miles.

Burlington, Cedar Rapids & Northern.—The *Pacific Division* is extended from Traer, Iowa, west by north to Rhinebeck, 11 miles.

Nebraska.—Extended from Seward, Neb., westward to Troy, 27 miles.

Colorado Central.—The *Floyd Hill Branch* is extended from Idaho Springs, Col., west to Georgetown, 9 miles. It is of 3 ft. gauge.

This makes a total of 101 miles of new railroad, making 943 miles completed in the United States in 1877, against 1,231 miles reported for the corresponding period in 1876, 607 in 1875, 916 in 1874, 2,028 in 1873, and 3,485 in 1872.

—A narrow-gauge railroad has been located from Des Moines, Iowa, to Webster City.

Improved Tug-Steamers are supplied by a Glasgow firm with two steam propellers—one at each end—which gives a greater hauling power than could be otherwise obtained.

An Experiment has been made with a locomotive to show the time of continual use, with due regard to economy, without repairs; it ran 70,000 miles in 11 months.

Poughkeepsie Bridge.—The caisson for the first pier is reported as down to the bed-rock on the river bottom. The second and third caissons are now being sunk to their respective places.—*Railroad Gazette.*

The Canal which the Government has Constructed to overcome the obstruction to navigation caused caused by the Des Moines Rapids in the Mississippi, at Keokuk, Iowa, was formerly opened with suitable ceremonies last Wednesday. The canal extends along the Iowa shore from Keokuk to Nashville, a distance of seven and six-tenths miles, is 300 feet wide in embankment and 250 wide in excavation; minimum depth of water, five feet; maximum depth, eight feet, which is sufficient to float the largest steamers that ply the waters of the upper Mississippi. The embankment enclosing the canal is ten feet in width on top, with a rip-rap covering two feet thick and carried two feet above extreme high water mark. The fall in the entire distance which the canal extends is 1,875 feet. There are two lift-locks and one guard-lock, each 350 feet long and 80 feet wide on top. These are built of solid cut-stone masonry, and are pronounced by experts who have examined them to be very substantial and highly creditable specimens of engineering skill. Sluices of sufficient capacity to control the surplus water carried into the canal by the numerous streams emptying therein during their frequent floods, are built around the locks. These were not included in the original estimate and have materially increased the cost of the work. The machinery for operating the lock-gates and wickets is made from an original design of Major Amos Stickney, the officer in local charge of the improvement. This plan consists of a system of pulleys, chains, and wire ropes, operated by means of a pump forcing the water into hydraulic cylinders sunk behind the walls back of each gate, connected by means of iron pipes, with an engine situated near the head of the lock, so that one man at the engine can handle the massive gates and wickets with ease and precision. The original estimate for this improvement was $3,390,000. It has cost so far $4,281,000. Work was begun on it in October 1867. It is estimated that $100,000 will yet be required to finish the work, and Congress will be asked to make an appropriation of this amount at the next session. The improvement is of incalculable importance to the navigation of the Mississippi river, as it removes the only obstruction now remaining between New Orleans and St. Paul.—*Engineering News*, iv, 228.

MINING, METALLURGY AND MINERALOGY.

Cinnabar Discovery in California.—A cinnabar ledge has been discovered about seven miles from Grass Valley, in the direction of Colfax. The ledge is reported to be from 75 to 80 feet in thickness, and, it is supposed, will yield 25 per cent. of quicksilver. In the course of a month or six weeks a furnace will be in operation.—*Grass Valley Union.*

Anthracite in New Mexico.—Reports of newspapers directly interested in the coal trade go to show that there are deposits of real anthracite coal in New Mexico, which needs only that great necessity, capital, to be brought out. A description of the quality of coal taken from a mine in that country is given in the Pottsville, (Pa.) *Journal*. "About 280 tons of coal have been taken from the first mine. It shows all the qualities of a true anthracite, contains 87.5 per cent of fixed carbon, and when burning shows only the short, blue flame of carbonic oxide. The steam boiler of the engine propelling the New Mexico Mining Company's stamp mill has been successfully heated by it. A hundred pounds brought to Santa Fe were used by Mr. Buckner in his assaying furnace, in order to test the heating powers practically. He found that a white heat was reached in a very short time, and that this lasted about three times as long as that produced by an equal weight of charcoal as the material does not choke in the least."—*Engineering News*, iv, 228.

—The antimony mines in Mississippi are yielding well.

—About one ton a day is now being turned out of the Dominion of Canada Plumbago mine at Buckingham. Shipments are being made to New York, Boston, Pittsburgh, Chicago, Philadelphia, Taunton, Mass., and other places.

A 6,000 Francs Prize for a New Process of Manufacturing Steel.—Among the divers propositions for 1878, before the Société d'Encouragement, we notice a prize of 6,000 francs for a new theory, founded on experiment, for the improved manufacture of steel. The point in question is to fix the theory of steel and to found it on the various results obtained in practice.—*Le Technologiste*, 1877, 74.

—The Southern gold mines are rising again to prominence, the products of North Carolina for the fiscal year 1875–6 amounting to $10,335,000 that of Georgia $7,379,000, and that of South Carolina to $1,381,000, a total of $19,095,000.

—A coal mine has been opened on the side of the Kittatinny Mountains, a few miles from Harrisburg. The vein has a depth of sixteen feet, and the coal, it is said, resembles that from Lykens Valley.

—The *Cologne Gazette* says that the trials made by the German Admiralty of different sorts of coal have shown that Westphalian coal is in many points superior to English coal, which was formerly used exclusively for the German steamers. These now take Westphalian coal in the German ports, but in foreign waters are compelled to take English coal. The association for the export of Westphalian coal now proposes to the government to establish, through the agency of well-known resident German merchants, coal stations at certain points—such as Flushing, Lisbon, Carthagena, Catania, and perhaps also Alexandria.

—The only locality in the United States, in which there is any prospect of success in mining for tin, is in Los Angeles county, California. On the Temescal ranche it is said to occur in considerable quantities, in porphyritic rock.—*Eng. Mech.*

—At Puerto Llano, in Ciudad, Real, Spain, a rich seam of coal, ten feet thick, has been discovered.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Analyses of Boiler Incrustations.—The *Chemical News* gives the complete analyses of the following incrustations: 1st, a brown cake, ½ inch thick, from a small egg-end boiler using water drawn from the middle coal measure; 2d, a very gray cake about ⅜ inch thick, from a boiler fed by water from Sheffield Water Co.'s mains; 3d, an extremely hard residue, 3 inch thick, from a tubular boiler near Sheffield, the water being pumped from a well:

	BROWN.	GREY.	HARD.
Calcium Sulphate	75.65	79.56	37.06
Calcium Carbonate	.....	5.05	.....
Silica	5.64	.....	.....
Ferric Oxide	4.71	1.53	38.98
Magnesic Oxide	4.85	5.34	10.36
Aluminic Oxide	.....	1.02	1.62
Water and Organic matter	8.61	7.75	8.80
Phosphoric Acid	trace.	absent.	.....
Carbonic Acid	.....	.....	2.58
Metallic Iron	.....	.....	trace.
Sodium and Potassium	trace.	trace.	trace.
	99.46	100.25	99.40

A Feat in Photography has been accomplished in San Francisco in photographing a race-horse while trotting at the rate of 36 feet in a second; during the exposure the rider's whip did not move the distance of its diameter.

For Prevention of Boiler Scale Herr Clouth employs a caoutchouc lacquer, which prevents the adhesion of the sediment to the walls of the boiler, so that the scale can be easily removed. After the scaling the boiler is left bright and smooth. The lacquer does not injure the iron, for its ingredients are only linseed oil and india-rubber.

On the Diathermancy of Rock Salt, Mr. Harrison describes some experiments which he has made and from which he concludes that it is not diathermanous to the extent it has generally been considered, but that it, partially at least, absorbs the incident radiant heat and then radiates from it as an independent body.—*Philos. Mag. June.*

The Electrolytic Deposit of Iron on copper possesses a hardness equal to steel. The salt generally employed for producing the deposit is double sulphate of iron and ammonia. The following solution given in the *Chemisches Centralblatt* seems to be more advantageous for this operation: Dissolve 155 grains of ferrocyanide of potassium and ¾ oz. of salt of seignette in 7 oz. of distilled water, and add to it 45 grains of ferric-sulphate, dissolved in 1¾ oz. of water; a precipitate of Prussian blue is thus produced. Add then, drop by drop, whilst stirring, caustic soda, until the precipitate is redissolved. A limpid yellowish solution is thus formed,

which is used as the bath for steeling the copper.—*Telegraphic Journal*, v, 178.

In the Chronometer Trials at Geneva during 1876–7, Professor Plantamour reports of the 63 chronometers supplied 41 stood the test successfully. H. R. Ekegren received the prize for a collection of 6 chronometers belonging to the same firm and giving the best mean results.

White Lead and its Oxidation.—Messrs. F. Weil and F. Jean have examined various brands of Dutch white leads. They found that all the leads when mixed with oil became yellow within twenty-four hours of the time of mixture. The yellow tint only showed itself in the centre of the mass, the surface remaining perfectly white. The lead did not contain the slightest trace of any foreign matter to which this strange phenomena could be ascribed, though the fault was beyond doubt in the lead and not in the oil, for even after perfectly pure oil of cloves was used the same fault was detected. Upon a close examination of the white lead it was found to contain free oxide of lead, and to this the yellowish tint was ascribed. This was doubtless the case, as the following experiment will show. The white lead was suspended in distilled water, exposed to the action of a carbonic acid stream and then dried. When now mixed with oil the yellow tint did not appear. This experiment also explained why the yellow color did not manifest itself on the surface of the lead. Being exposed to the air it took up sufficient carbonic acid, while the interior of the mass could not be reached where the oxide predominated and imparted the yellow tint. These deductions were further proved by subsequent experiments.—*Ind. Ztg.*, 1877, 307.

Printing Inks from Coal Gas Residues.—Two French chemists have taken out a patent to manufacture printing ink from the residue of gas works, from tar, heavy oils, etc. These substances can be very easily mixed with lamp-black or any other coloring powder. The inks thus derived possess many advantages, among others, that they do not penetrate into the pores of the paper very rapidly and do not easily blot. The component parts are generally: Tar 10 parts, lamp-black 36 parts, Prussian blue 10 parts, glycerin 10 parts.—*Génie Civil*, vi.

Electrical Illumination.—At the last meeting of the German Gas Engineers, held at Leipzig, the subject of electric illumination was again introduced. Director Oechelhäuser, of Dessau, related his observations, mostly made in France, and called especial attention to the extent that electric light might compete with gas illumination. By comparing the expense of its application, even by the flattering figures of the French manufacturers of apparatus, it was clearly proven that gas was so much less expensive that no serious thoughts of its ever being succeeded by electric light need be entertained. Gas Director Henning, of Danzig, also instigated investigations of costs with favorable conclusions for gas illumination; and Dr. Bunte, of Munich, asserted that the combustion of gas under the same conditions required much less mechanical force than electric light would. Engineer Grahn, of Essen, asserted that explosions were more imminent in electric illumination, and spoke of many other defects, especially the injury to the eye-sight, if both gas and electric illumination should be used.—*Ind. Ztg.*, 1877, 306,

In testing the comparative explosiveness of nitroglycerine in the crystallized and the liquid state, Beckerheim used a drop-block of wrought iron weighing 2.130 kilogrammes, having at its lower end a hardened steel point of 7.068 square millimetres. The nitro-glycerine was spread in a thin layer on a flat anvil of Bessemer steel, and the weight was dropped from different heights. The liquor exploded at a fall of 0.78 metre, but the crystallized or frozen nitro-glycerine only at 2.13 metres.—*Pop. Sci. Monthly, Sept.*

Photography in Germany.—At the last session of the Berlin Photographic Society a report was presented on the extent of photography in Germany, from which we glean some interesting statistics. In the German Empire there are 3,000 photographers, who require each on an average 3 lbs. of nitrate of silver annually. Austria possesses the same number of photographers, but the average annual consumption of nitrate of silver is but 1 lb. Germany manufactures 20,000 reams of albuminized paper annually, of which but 1,000 are for home use. 40,000,000 cartes-de-visite were prepared in Germany during 1876.—*Nature*, xvi, 257.

Geographical Exploration in Africa will form, it is said, a prominent subject at the British Association meeting, the chief points to be submitted to discussion being the establishment of stations at certain spots in the interior, and the systematic exploration of given districts. The arrangements for the meeting are now complete, but at present it seems only too probable that Sir Walter Elliot will be unable to take his position as President of the Department of Anthropology. Prof. Odling will deliver the lecture on Monday, the 20th, taking for his subject the "new element, gallium."—*Eng. Mech.*, xxv, 506.

Subterranean Telegraphy.—The last portion of the great underground cable from Berlin to Mayence was laid at the latter place on Monday week in the presence of the Postmaster-General of Germany, a numerous staff, and a large number of gentlemen. The Emperor William sent a telegram from Gastein, congratulating the Postmaster-General and those assembled on the completion of the work. This event deserves notice, for the Berlin and Mayence cable is the first long subterranean cable that has been laid down. In 1848 Germany laid down a wire between Berlin and Cologne, but this proved a total failure. The process of manufacturing gutta percha and making cables was then imperfect. For instance, sulphur, the greatest enemy to gutta-percha, was mixed with it. The result was that after a few weeks the faults multiplied to such an extent that correspondence became impossible. This created a prejudice against subterranean telegraphy, and more than 25 years elapsed before an underground cable on a large scale could be projected. The cable is about 600 kilometres in length, and passes from Berlin through Halle, Leipsic, and Frankfort to Mayence, the wires twisted together, and covered with hemp and iron. The cost is about six times more than the same number of overground wires would cost. Germany now possesses seven underground lines between its capital and its western frontier.—*English Mechanic*, xxv, 507.

A Competitor of Nickel.—We will soon hear of columbium-plating, a metal which is very much like nickel, but whiter, like tin, It was first found, more than fifty years ago, in the United States, near Middletown, Conn., and named in honor of America. It was thus far very scarce, but has now been found at Marion, N. C., and also in the Amazon stone of Colorado. If it becomes abundant enough to be used in the arts, we may soon have a valuable addition to the useful metals, and also to their compounds or salts. The metal forms an acid like tin, called columbic acid; tin forms stannic acid, and the compounds of this acid with bases, are stannates, very useful in the arts; the compounds of columbic acid with bases, must be called columbates. They have not yet been investigated, but will likely be found extremely useful for some purposes.—*Manuf. and Builder*, ix, 183.

The Age of the Sun and Fixed Stars.—In a recent communication to the American Philosophical Society on the relative ages of the sun and certain fixed stars, Prof. Kirkwood comes to the following conclusions:—(1) The history of the solar system is comprised within 20 or 30 millions of years. (2) From the fact that the larger component of Alpha Centauri radiates twice as much light as the sun, while the mass of the former is less than that of the latter, we infer the probability that our solar system is more advanced in its physical history. (3) 61 Cygni seems to have reached a greater degree of condensation than the sun; since, on the hypothesis of equal density, the surface of the larger member is one-third that of the sun, while the intrinsic light is less than one-ninth. (4) The companion of Sirius seems to have reached a stage of greater maturity than the sun, while the contrary seems to be true of the principal stars.—*Eng. Mech.* xxv, 533.

Iron-sponge Filters are recommended, even as superior to charcoal filters for removing organic impurities from drinking water. They consist of spongy metalic iron, prepared without fusion, and remain much longer active than any other. They were first proposed by Prof. Gust. Bischof in Glasgow, and may be had from Leybold in Cologne, and E. Voss in Hamburg.—*New Remedies*, vi, 256.

New Characters for the Blind.—M. Recordon, of Geneva, has invented a machine by which blind people can write at once in characters meant for their blind brethren, and in ordinary letters legible with the eyes. A writer in *Le Temps* states that at the Asylum of Quinze Vingts he saw it in operation; and a few phrases which he himself wrote with it, without any preparatory study, were deciphered immediately with surprising rapidity. The blind in France use at present a special alphabet, formed by grouping of six points, and invented fifty years ago by a blind person, M. Baelle. With this alphabet the books of the blind are much less voluminous.—*English Mechanic*, xxv, 506.

Manufacture of Chlorine by Deacon's Process.—A. C. Jurisch.—The author examines the causes which interfere with or hinder the production of chlorine in Deacon's process. Like M. Hasenclever he arrives at the result that the perturbations observed are due to sulphuric acid, but whilst Hasenclever ascribes this influence to a chemical action the author pronounces it chiefly mechanical, the balls of clay becoming coated with an inert layer. He points out that the proportion of hydrochloric acid decomposed depends on three factors: (1.) The proportions of the mixture of air and hydrochloric acid gas. (2.) The rapidity of the gaseous current. (3.) The temperature of the gaseous mixture and of the balls of clay. The proportion of hydrochloric acid in the gaseous mixture varies from 20 to 60 per cent. Mr. Hurter has found that, other conditions being equal, the relative quantity of hydrochloric acid decomposed diminishes with the proportion of air, and increases with the dilution of the hydrochloric acid. The quantity of hydrochloric acid decomposed is the greater the slower is the gaseous current. The decomposition of hydrochloric acid augments with the rise of temperature.—*Dingler's Polytechnisches Journal, per Scientific American Supplement*, iv, 1368.

A New Disinfectant.—While investigating the hygienic properties of pine and eucalyptus, Charles T. Kingzett found that by exposing a mechanical mixture of water and turpentine to a current of air at normal summer temperature, a solution containing hydrogen peroxide—a powerful disinfecting and oxidizing agent—and camphoric acid may be readily obtained. This solution contains no oil of turpentine, is non-poisonous, and without harm to textile fabrics.—*Pop. Sci. Monthly, Sept.*

Zinc as an Adulterant of Caoutchouc.—The attention of the French Administration has lately been called to a statement published in German journals informing the public that caoutchouc toys of French manufacture had been analyzed and found to contain considerable quantities of oxide of zinc, rendering them highly dangerous. The Minister of Agriculture and Commerce invited the Consulting Committee of Public Hygiene to examine the question, and find whether caoutchouc, combined with oxide of zinc and vulcanized, may or may not be considered harmless. The committee, after a careful examination of toys, state that the composition which forms the base of these contains only caoutchouc, carbonate of lime, sulphur, and oxide of zinc, the last completely exempt from arsenic. Their decision is thus formulated:—"Caoutchouc, combined with oxide of zinc and vulcanized, is completely inoffensive; the toys into which this composition enters alone cannot cause accidents of any sort, even in children of the earliest age, and the fears aroused in this connection are quite without foundation.—*Eng. Mech.*, xxv, 482.

On the Principles of Tanning.—It was formerly believed that leather was a true chemical combination formed by the hide and the astringent matter. The researches of Knapp have thrown new light upon this question, proving that leather cannot possibly be a chemical compound. He has succeeded in making leather without any tanning matter by merely driving the water out of the pores of the hide by means of chloride of calcium and anhydrous ether, and he has then reconverted this leather into its original state of hide by leaving it to steep in water. The experiments of Knapp show that in tanning the special agents are not absorbed by the hide in an invariable quantity, but that the proportions depend on the degree of concentration and on the nature of the solvent. To penetrate into the hide to enfold the fibres, to cover them with a precipitate by surface attraction—this is the only part played by the tanning principles. Thanks to their presence, the fibres during the drying of the hide do not form a horny mass, but remain supple and flexible. Leather is not a chemical compound, but rather a mechanical mixture. Knapp considers tanning only as a special case of dyeing.—*Hoffmann's Report.*

The Electrical Illumination of the Lyons Railway Station is being completed. They are now using twelve electric lamps. This number will be enlarged successively to twenty-four lamps, fed with one light-producing and one light-distributing machine. It is believed that twenty-two horse-power will give a power of 2,400 gas-lamps, using 100 litres each per hour.—*Nature*, xvi, 297.

Chlorophyll, or the coloring matter of plants, has been found by M. Frémy (as our readers may know) to consist of two principal constituents: one yellow, and called by him *phylloxanthin*, and the other a dark bluish-green, which he calls *phyllocyanic* acid. Having further inquired into the manner in which the substances occur in the organic tissue, he concludes that "the coloring matter of leaves is a mixture of phylloxanthin and phyllocyanate of potash.—*Eng, Mech.*, xxv, 482.

MISCELLANEOUS.

Peppermint Farming.—The cultivation of peppermint is carried on to a greater extent in Michigan than elsewhere, about two-thirds of the whole crop of the United States being produced there. The black ash swamps of Western New York and the river bottoms soils are the best adapted to the growth of this article of commerce. The land must be drained to allow its being worked easly in spring. The "seed" used is one-years roots, taking from 10 to 20 square rods to plant an acre. These roots are planted in freshly plowed land in rows; the space between the rows, from 18 to 36 inches, according to the nature and richness of the soil, and the mode of cultivation adopted by the grower. During the first year the mint must be kept free from weeds. It yields the most oil when in blossom, or a little past, and must

be cut on a dry day. In 24 or 48 hours after cutting it is carried to the still and the oil is extracted. There must be a good supply of water to make distilling successful. It is at this point that the careful calculator saves money. If dried too much, there is a loss in leaves falling off and the yield of oil greatly diminished. The mint straw, being carefully dried, is readily eaten by animals in winter, and makes a good covering for strawberry beds, as there are no seeds in it to germinate. The oil is principally used in medicine and babes' candy, and it is said sometime used for making cordials. The present product is about 60,000 to 70,000 pounds, annually. There always has been a sale for it, and by far the greater part is sold in Europe. Like every other farm product it is sometimes above and sometimes below the cost of production.

Paper Chimneys.—In Breslau, according to the *Centralbl. f. d. Textil-Ind.*, a successful attempt was made to erect a paper chimney, an invention long known and used in America and England. The one erected was about 50 feet high. By a chemical preparation the paper is rendered impervious to the action of fire or water.—*Oestr. Montan-Ztg.*, v, xi, 30.

[We would be gratified to learn where this curious and doubtfully practical device "has been used in America." It is certainly quite new to us.]

New Danger from the American Grape Parasite.—M. Mares, in speaking of the new danger to the French vineyard, by the introduction of the American grape parasite, says it consists in the transmission of the phylloxera of the American grape to the French vineyards. The fact has been clearly proven in the case of many varieties of French grape, and merits speedy and very serious consideration. A recipe for the extermination of the phylloxera, which has been proposed by a Neuchâtel wine grower, consists of a compound of 10 litres of liquid cow manure and 2 litres of sulphuric acid, with which the infested stocks are to be washed. M. Dumas is disposed to think that every grape will not endure such radical treatment. M. Macagne, writing on the subject of the grape cancer, which has lately appeared in the environs of Narbonne, conforms with the opinion of M. Cornu, that it is a parasitical growth of which the phylloxera is the cause.—*La Nature*, v, 158.

Collapsible Boats.—Rev. E. L. Berthon read before the Society of Arts, London, an interesting history of lifeboats, describing the many wrecked vessels that were supplied with the necessary number of boats in compliance with law, yet when occasion required their use, failure presented itself, principally for the reason that the lifeboats could not afford room for the great numbers seeking safety on account of their fewness. Usually they were calculated to hold about one-third of the capacity of the vessel. This lamentable deficiency has been made apparent in many cases that have brought sad results to all, and it yet exists in every direction. Great numbers of ocean-going vessels with numbers of people are passing to and fro with no adequate means of safety. It is estimated that "not one vessel has boats of any kind capable of saving one-half the people on board in case of the occurrence of fire, wreck or collision."

Mr. Berthon suggests the use of a collapsible boat which he invented. A quarter of a century has seen and approved their use; they may be found in all parts of the world. This collapsible boat is so arranged as to fold up lengthwise. It occupies very little space in comparison to its size. The inventor describes his boat as follows: "The framework is chiefly of wood, of the strongest and most elastic kind. To the keelson, or backbone of the boat, the stem and stern-posts are attached, and on each side are four longitudinal curved timbers, which are jointed to the tops of the former by a peculiar kind of chain hinge. When shut, these timbers fall down on each side of the keelson in vertical and parallel planes; and when open they assume such positions as to form the skeleton of a boat, extending two skins (one outside, the other inside) of a very strong and highly flexible material. The whole body of the boat is thus divided into eight segmental compartments, into which air is inhaled automatically by the act of expansion. These cells being all separate and water-tight, any injury that might befal one of them does not affect the others, nor materially impair the safety of the boat." The frame-work is quite strong enough to bear the weight of a boat load when suspended. The embarking and disembarking of 8 horses and a heavy field gun has been performed in the most satisfactory manner in the trials ordered by admiralty. As pleasure boats they have been used with success.

The Telephone has been put to a practical use in New York. There are five wires in operation. The piers of the new Brooklyn bridge are connected with the Superintendent's office, so that all the movements of the "travellers" in carrying the wires are communicated and directed by the telephone instead of signal flags previously used.

The Jarvis Furnace Company send us the results of some tests in evaporation made on boilers built by William Allen & Son, Worcester, Mass.; one set with the Jarvis Patent Furnace, and the other with the Allen setting, at the Wicks Manufacturing Company's Mill in Worcester. The boilers were each five by seventeen feet, with eighty-three inch tubes, set side by side, both entering same flue and chimney. During these tests the Allen boiler required assistance all the time excepting thirty minutes, while the "Jarvis" run the works all day without any assistance, and run from twenty to twenty-two horse-power more work. The gain in capacity is very large, showing that with 365 pounds more of coal the "Jarvis" evaporated 5,681 pounds more of water into steam, or that three boilers set with the "Jarvis" will do as much work as five on the old style of setting.

The Record shows:	Allen Setting.	Jarvis. Setting.
Pressure of steam	65lbs.	80lbs.
Pounds of water evaporated	8,313	13,994
Temperature of water	70°	70°
Pounds of water evaporated per pound of coal	7.32	9.33
Pounds of water evaporated per pound of combustible	7.66	9.83

Gain in economy in favor of Jarvis Furnace, 27.58 per cent.
Gain in capacity in favor of Jarvis Furnace, 68.45 "

Over 25 textile mills, besides large numbers of paper, and other mills, are now using boilers with this setting.

Feeling the Pulse by Telegraph.—Some months ago Dr. Upham, of Salem, Mass., in order to explain to his audience the variations of pulse in certain diseases, caused the lecture-room to be placed in telegraphic communication with the city hospital of Boston, distant 15 miles, and by means of special apparatus the various pulse beats were exhibited by a vibrating ray of magnesium light upon the wall. These experiments have lately been repeated at Paris with success.—*New Remedies*, vi, 244.

Spontaneous Generation Controversy.—Dr. Bastian went to Paris lately to submit his experiments on spontaneous generation to the commission appointed by the French Academy. M. Pasteur courteously offered him the use of his laboratory, and we shall probably before long have the opinion of the commissioners on the questions in dispute between M. Pasteur and Dr. Bastian. The latter communicated a paper to the Linnæan Society a week or so since, in which he states his views, and replies to the arguments of Prof. Tyndall.

Japan.—With reference to the question of opening up Japan, a Yokohama paper mentions a somewhat curious fact. The Satsuma people, who were most opposed to foreigners being allowed even a *pied à terre* in Japan, are now said to be those who are most keenly alive to the advantages to be derived from extended intercourse with them. It has been asserted, on good authority, that one of Saigo's demands is that many of the restrictions placed on foreigners shall be removed, and that they shall even be invited to employ their capital in the development of mining and other industries.—*Iron*, x, 132.

Prizes for Alloys.—The Council of the Prussian Association for the Promotion of Industry announce that they will award the following prizes this year and next:—For the best series of alloys of iron and manganese, £100; for a process for separating cyanide and ferro-cyanide of potassium from sulpho-cyanide of ammonium by means of potassium compounds, £50; for a process for utilizing anthracite oils in the preparation of aniline and alizarin, £75.

Irrigation and Filtration.—Dr. de Play divided a strip of meadow into four divisions, situated on a common incline, flooded eaeh division with ordinary tank manure, diluted, and collected and analyzed the water as it respectively passed out of one plot to flow into another. He found that not only the chief portion of the ammonia, but the phosphoric acid, potash, etc., were absorbed by the first plot, to the detriment of the others; that in proportion as the water was distant from the first division, it became less rich as a matter of course—for the first bed of a filter stops the largest percentage of impurities, and that this relative poverty prevented water from parting even with its reduced stock for fertilizers. In practice, the direction of the head manuring stream is changed from time to time.—*Paris Letter.*

Colored Backs of Books —Brown and black are the only fast colors in book-binding cloth. Red, green, and blue are the next nearest to fast colors. In calf binding, yellow or tan is the only color that will not fade. It wears best. Blue calf wears and rubs white. Purple and wine colors fade very quickly if exposed to light. Claret is greatly superior to the last named, and is nearly fast.

—Boxes are made in London direct from the paper pulp. Four machines, with the drying stoves, produce 600 boxes or covers in an hour without the employment of skilled labor.

Three New Steamers built and engined by Messrs. Simons, of Renfrew, alike in every respect, 1000 tons burden, compound engines, 400 horse-power nominal, have been placed on the line from Milford, (England), to Waterford, (Ireland).

Corinthian Raisins.—About the middle of July commences the harvesting of grapes, which brings to Greece the annual income of from seven to nearly nine million dollars. The Corinthian bay is converted into a profitable enterprise. The time is one of excitement for the laborers and the many women and children who are engaged in the harvesting. During the first day the huts and tents are prepared. In the meantime the drying floors have been made ready on a suitable piece of ground; coopers are engaged in making barrels for the packing. The English steamers are looked for anxiously. All, from the carriers of burdens to the wholesale commissioners and merchants, expect high wages and profit from this monopoly of a portion of Greece and the Ionian islands. After ten or twelve sunny days the fruit is made ready for the packing and storage in the warehouses; the weighing and packing is done under the supervision of the government. Each shipmaster is desirous of securing the first cargo, and the departure of the vessel carrying the so-called *primaroles* is the occasion of festivities, adorning the ship with wreaths and firing of cannon. A heavy rain is feared as the cause of disappointing the hopes of a great number of families. There are fifty varieties of grapes, yielding as many different wines. A number of years ago attempts were made to transplant the valuable vines of Hungary and Germany to Greece; though they flourished, the acidulated grape of the Rhine produced a wine resmbling those obtained from indigenous grapes, and the latter acquired a harsh and acid taste when cultivated in the above-named countries.

The Suez Canal.—The transit revenue of the Suez Canal Company in 1870 amounted to £206,360. In 1871, the corresponding revenue was £359,720; in 1872, £656,280; in 1873, £915,980; in 1874, £994,362; in 1875, £1,155,440; and in 1876, £1,198,960. The number of ships which passed through the canal in 1876 was 1,457, and the aggregate weight of goods carried through it during the year was 3,072,000 tons. In the first five months of 1877, 766 vessels passed through the canal, and the transit revenue collected amounted to £600,929. The corresponding movement in the corresponding period of 1876 comprised 692 ships, while the transit revenue collected in the first five months of 1876 was £549, 315. It will be seen that the transit revenue increased last year to the extent of £43,520, as compared with 1875, while in the first five months of this year, as compared with the corresponding period of 1876, the corresponding increase was £51,614.—*Jour. Soc. of Arts*, xxv, 882.

Award of the Lavoisier Medal.—The Lavoisier Medal of the Société d'Encouragement pour l'Industrie Nationale has just been given to an Englishman, Mr. Walter Weldon, F.R.S.E. In presenting it M. Dumas congratulated Mr. Weldon upon having cheapened every sheet of paper and every yard of calico made in the world; and at the meeting at which the presentation took place Prof. Lamy stated that whereas at the date of the introduction of Mr. Weldon's invention, seven or eight years ago, the total bleaching-powder made in the world was only about 55,000 tons per annum—it is now over 150,000 tons per annum; and that of this vast quantity fully 90 per cent is made by the Weldon process. The Lavoisier Medal had been awarded only once before, namely, in 1870, to M. Henri Sainte-Claire Deville.

Telegraphic Consolidation.—Several conferences have recently been held between prominent representatives of the Western Union and Atlantic and Pacific telegraph companies, which were designed to effect a consolidation of the interests of those organizations, either by pooling the earnings, a lease, an exchange of stock, or some other method, but it is said that no binding arrangement has yet been made.—*Railway World*, iii, 770.

—The Jackson & Sharp Company, of Wilmington, Delaware, has received by cable from Norway an order to build a palace car for his majesty, Oscar II., King of Sweden and Norway. The car will be similar to the narrow-gauge palace car "Dom Pedro II," built by this company for the Emperor of Brazil, and for which it was awarded the prize at the Centennial Exhibition. The company has recently shipped five cars to South America, and is building four more for that continent. It has also, as before noticed, shipped three fine cars to Australia.—*Railway World.*

—A new narrow gauge road is projected to run from Columbus, Ohio, by the way of West Jefferson, Madison Co., and Mechanicsburg, to Urbana. Subscriptions to the amount of $20,000 have been secured in Urbana, which city is also to defray her part of the expenses of making a preliminary survey of the proposed line.

—The work of changing the gauge of Wallkill valley Railroad, from 6 feet to 4 feet 8½ inches, will soon be commenced. About 1,500 tons of steel rails have been purchased. The rails will be laid inside the present rails, and will lay about 16⅛ miles. After these are laid the old rails will be taken up, and enough used to narrow-gauge the balance of the road, 26¾ miles.

—The automatic railroad for unloading ore was put in operation for the first time on the Lake Shore and Michigan Southern Railway docks, at Ashtabula, recently. The ore is hoisted in buckets to the cars by steam, and the cars are run down an inclined plane and dumped.—*Railway World.*

—The world now produces more beet-root than cane sugar, and the United States would profit by imitating the example thus set. Could we raise what we consume at home, it would save us over $50,000,000 a year.—*Manuf. Mech. Adv.*

—An American palace-car, with dining-room attached is doing a good business on a Belgian railroad.

—The Black Hills railroad survey corps which was recently camped on Running Water, 60 miles north of Fort Laramie, expected to reach Custer City about the 31st ult.

—The Columbia Bridge Works, of Dayton, Ohio, were awarded eleven contracts, for bridges, on the 7th inst., four of them to be constructed in Indiana, and the others in Ohio. They will range in length from seventy-five to two hundred and twenty-five feet. Work was begun on one of these across Wolf creek, two miles from Dayton, on the 8th inst. It is to be of iron, a single span one hundred and seventy-five feet long. The rush of work will make necessary the employment of an increased force of men.—*Engineering News.*

—The municipal authorities of Paris tax lightly the broad wheel-tires on the asphalt pavement.

—During the fiscal year ending June 30, 1,060,353,909 stamps were used in this country, valued at $26,525,836.47.

—On the Denver & Rio Grande Railroad the highest point 9,340 feet, reached by any railroad in this country is on the summit of Lavera Pass, Nevada.

—The Troy *Times* says the Bessemer Steel Works at that place is running to its full capacity. Large orders are on hand for a new modification of Bessemer steel, intended for the manufacture of edged tools and other implements, and the orders for steel rails are also quite extensive. Large purchases of coal and iron have recently been made by the company, and unless some unforeseen accident occurs the works will no doubt be run continuously throughout the summer and fall.

—We learn from the *Age of Steel* that the Western Iron Boat Building Company, of St. Louis, have just completed a handsome iron propeller for General Price, to be used as a mail boat in the Gulf. It is of iron timbers and 3-16 inch plate covering, and is one of the neatest things afloat. The same company have also just completed two more iron freight cars.

—There are in Prussia 1,678 establishments for getting ore, smelting, and steel making, affording employment to 114,000, persons. The number engaged in working the iron and steel is 215,000, distributed among 91,000 establishments.

—The German Anthropological Society holds its eighth annual congress at Constance on September 26.

EDITORIAL CORRESPONDENCE.

COOLING OF CASTINGS.

163 STRAND, London, W. C.

Editors POLYTECHNIC REV. : *Gentlemen*—Referring to your interesting little article on the above subject in the POLYTECHNIC REVIEW of the 28th ult., it may be interesting to some of your readers to know that the subject is very fully treated in "The physical conditions involved in the construction of artillery," by Mallet, who was the first to investigate the origin of the plans of weakness of the description referred to, in heavy castings, and to draw attention to the fact that the long axes of the iron crystals always assume positions normal to the cooling surface, or successive cooling *couches* of a casting. This is, as you say, particularly illustrated in large chilled castings such as the broken shot in your illustration. B. W. W.

ANSWERS TO CORRESPONDENTS.

J. W. F., Philadelphia, sends us the following problem for solution : A General is in command of a marching army, the column of which is 25 miles long ; he rides from the front to the rear and returns. On his return to the head of the column he cries halt ! and finds that the army has marched 15 miles in the interval. Query : how far did the General ride ?

Solution—Let r = officer's rate of motion, that of the army being 1.

Let x = distance army travels while officer rides down the column.

Then rx = distance the officer travels in the same time.

$15 - x$ = distance column travels while officer returns,

and $15r - rx$ = distance officer travels on his return ;

but $x + rx = 25$ (1)

and

$$15r - rx - (15 - x) = 25 \text{ or}$$

$$15r - rx + x - 15 = 25 \text{ ; by combining}$$

this by addition with (1)

$$15r + 2x - 15 = 50,$$

but from (1) $r = \frac{25x}{x}$ $\therefore$ $\frac{375 - 15x}{x} \times 2x - 15 = 50$

$$\text{or } 375 - 15x + 2x^2 - 15x = 50x$$

$$2x^2 - 80x = -375, \text{ from which}$$

$$x = 5$$

substituting this value in equation $r = \frac{25 - x}{x}$, $r = 4$

The entire distance the officer travels equals $rx + 15r - rx = 15r$ or 60 miles. S. A.

ENDLESS SCREW. (T. H., Indianapolis) There is no such thing in reality. Where one side of a nut is wrapped around a wheel and called worm-wheel, the screw which engages in these nut-threads has no endwise motion, as it is intended to cause motion in the nut (worm-wheel). If either element of such a pair were an endless screw, it would be the wheel, which has an endless half female screw upon its periphery.

RAPE OIL. (DeW. M., Buffalo, N. Y.) This is not good for high speeds or light pressures.

BIBLIOGRAPHICAL NOTICES

THE ELEMENTS OF MECHANISM. Designed for Students of Applied Mechanics. By T. M. Goodeve, M. A. 269 pp. 16mo. D. Appleton & Co., New York.

This little work, which is No. 6 of the excellent "Text-Books of Science" series, is one of the most reliable and useful little works we have ever read. It is clear without being profuse and accurate without being complicated. The 257 wood-cut illustrations and their accompanying descriptive matter are well chosen, and the generalizations both simple and thorough. Illustrations are very largely drawn from actual practice, and the sources named, so that the reader or student feels that he is obtaining both theory and practical information. This is about as far removed from being a piece of mere "bookmaking" as anything that we have seen for some time.

WORKSHOP APPLIANCES, by C. P. B. Shelley, is No. 3987 of the same excellent series. From the nature of its subject and the place of original publication (the Longmans of London are the real publishers), we find the instances of practice mainly drawn from British usage, and hence we miss many American appliances, notably in the lines of radial and portable drills, automatic gear cutters, lathe-chucks, shaft-couplings and hangers, twist-drill grinders, emery-wheel and milling machines, M-tooth saw, increment cut file, parallel vises, &c. Holtzapffel is very largely drawn from, which could not well be helped, and is, in fact, a good point ; but the author slightly differs from Holtzapffel in tool classifications. If now the American publishers were only to have an American edition, prepared by such able hands as those of Prof. Sweet, the work, already commendable, would be much more desirable on this side (and possibly on the other) of the Atlantic.

SELECTED LIST OF U. S PATENTS.

JULY 31, 1877.

Patents granted July 31, 1877, 207. Reissues, 13. Designs, 7. Trade-marks, 25. Labels, 11.

193,590. HAND-PLANTERS. S. P. Babcock, Adrian, Mich.

On a stop-block is adjustably secured a metal block for graduating the depth of penetration. The removable scraper-plate is held in position by spring arms. The plunger is tapered at its lower end to render it self-cleaning. Within the hopper, above the discharge orifice, is removably secured an inverted hood, to prevent crowding of the corn. The handle of the plunger is secured to it by a flanged sleeve, the base-flange of which is let into the face of the standard.

193,600. VALVES FOR DIRECT-ACTING PUMPS. G. W. Dixon, Spring Lake, assignor to Wm. M. Ferry, Grand Haven, Mich.

An auxiliary port in the valve and cylinder admits steam to the latter, to carry the pump over the dead point.

193,607. DIES FOR WELDING LINKS. J. H. Helm, Allegheny, Pa.

The inclined planes of the die-blocks and the cavities therein operate so as to concentrate the force of the movable die-block upon the portion of the link to be welded, and they are so constructed that the inner line of parting of the die proper dips below and the outer line rises above their respective planes throughout the portions that embrace the sides of the link.

193,609. SLIDE-RESTS FOR WATCHMAKERS' LATHES. Caleb Hopkins, Waltham, Mass.

The foundation piece of the rest is formed with ways for a slide to move on, and this slide is provided on top with the half, and the piece above it with the other half, of a turn-table. A pierced bolt connects these halves, and when it is desired to draw them together, and prevent the upper half from revolving upon the lower, a wedge-pointed screw is inserted in the hole of the bolt. Integral with the said upper half is another piece, formed with ways for the reception of the slide, which carries the tool-post. A threaded stem on this slide receives the nut for raising or lowering, as desired, the tool-post, which may be freely revolved, unless clamped to the stem and nut by a nut which engages with the threaded end of the connecting-bolt.

193,618. HUB-BORING MACHINES. R. G. Rowe and I. B. Edington, Waterloo, N. Y.

By means of a curved cutter, pivoted to the lower end of a hollow feeding-screw, and attached to the lower end of a rod extending through the screw, and operated by a nut upon the upper end of said rod, an enlargement is cut in the interior of the hub, so that the ends of the spokes will not touch the box when secured in place The hub is held in a circular clamp attached to an interior-threaded sleeve, vertically adjusted upon the feeding-screw, by means of two spring-acted levers, provided with sectional nuts working in slots in said sleeve, and secured in position by an eccentric pivoted to an arm attached to the outer end of one of said levers.

193,625. HYDRAULIC RAILROAD-SIGNALS. Harvey Tilden, Cleveland, Ohio.

Water, oil, or other equivalent liquid is pumped from a resevoir into a cylinder having a heavy or weighted piston, and thereby is forced through a pipe provided with one or more stop-cocks or valves, and a cylinder or plunger at its opposite end, to which is connected a signal target or other device, to be moved or otherwise operated.

193,633. HINGES. J. Beaudet, Cambridgeport, Mass.

Two hinge-screws, provided with globular heads, are inserted obliquely in the door and frame, and united by a pivotal screw or pintle passing through the head of one and screwed into the head of the other. The lower pair of hinge-screws, similar in construction and arrangement, are united by a pintle flanged in the middle, and cannot readily be detached from each other when the upper pair are screwed together.

193,644. MACHINES FOR MAKING BOLTS. George Dunham, Unionville, Conn.

The feed-rolls and the die-rolls oscillate, and the latter are provided with griping and angular-shaping die-surfaces, and carry shears. The heated bar is fed to the griping surfaces of the die-rolls and held, when it is seized by the upsetting-jaws and upset, to provide metal for the square neck. The feed-rolls again oscillate, thrusting the rod forward between the angular-shaping surfaces of the rolls, which reciprocate toward the feed-rolls, to enable that to be done. The preliminary shaping having been done, and the end of the rod having been seized by the transferring tongs, the blank is severed and carried to the holding and turning jaws, which receive and hold it, while the heading and squaring dies do their work, and turn between the two strokes of the squaring-dies.

193,646. ATTACHMENTS TO KNITTING-MACHINES FOR RE-ENFORCING THE KNEE-CAPS OF STOCKINGS. John J. Fitzpatrick, Philadelphia, Pa.

An attachment by which the thickness of that part of a stocking which covers the knee-cap is increased by laying an extra thread by the side of the regular thread for two inches, more or less, on the front side of the stocking.

193,648. MACHINERY FOR THE ARTIFICIAL PRODUCTION OF COLD FOR ICE-MAKING, &c. Paul Giffard, Paris, France.

The air is compressed by a piston and accumulated in a reservoir, and at each stroke of the piston the compressed air is deprived of its heat by the injection of water. The cold compressed air passes into the expansion cylinder. In expanding, the air becomes extremely cold. The packing of the piston is of rubber, and expands by the action of the compressed air.

193,672. PERFORATING APPARATUS FOR ELECTRIC TELEGRAPHS. C. A. Randall, New York, N. Y.

For perforating paper to be used in the system of telegraphy in which transmitter and receiver run synchronously, and the distances between the perforations correspond to the distances in the "type-circuit" wheel between the characters to be recorded.

193,681. DOOR SPRINGS. Arthur P. Yates, Syracuse, N. Y.

A semi-elliptical spring, arranged in vertical position within a recess near the edge of the door, is held in place and concealed by a face-plate provided near the middle with inwardly-projecting guide-posts. There are also combined with the spring and face-plate a screw, mounted in the plate and carrying a nut as means of adjusting the tension of the spring, and smaller guide-posts at the upper end, to prevent undue vertical movement, the ordinary link-connection passing through an aperture in the face-plate to connect with the inner edge of the door-frame.

193,691. FEEDING MECHANISMS FOR SEWING-MACHINES. Mathias Christopherson, Chicago, Ill.

The feed may, at will, be converted from a plain four-motion to a six-motion or zigzag feed by throwing it into or out of gear with a gear on the shaft carrying the cam for giving the four motions. A gear mounted on a pivoted frame, and carrying on its shaft a cam for giving the additional lateral motions.

193,700. COTTON-GIN FLUES. Locke C. Grover, Grenada, Miss.

The flue has an upwardly-inclined and hinged bottom, and parallel or nearly so to the upper wall of said flue is a reticulated diaphragm, over which the cotton passes on its way to the batting-rollers, and whereby it is deprived of the fine dust or foreign matter that has not been deposited on the mote-board.

193,728. WINDMILLS. S. Rittenhouse, Pioneer, Ohio.

A supplementary vane is used in high winds only, and its effect is to regulate the position of the main vane and that of the wheel in such a manner that the motion of the wheel shall be no faster in spite of the increased force of the wind ; and also in the arrangement in the water-tank of a board pivoted to a lever, the other end of which is connected by a chain to the supplementary vane, and the result of which is, when the tank is full, to throw the supplementary vane into, and the main vane out of, gear, so that the wheel is set at an angle to the wind, and thus slackening its speed until the water in the tank runs low, when the vanes and wheel are automatically reset in their former position.

193,782. HARNESS-MOTIONS FOR LOOMS. John Shinn, Philadelphia, Pa.

The invention consists in special combinations of devices for procuring an open shed. The jacks have double hooks at each end, one of said hooks being adapted to be operated by the lifter or depressor, and the other to be caught by the retaining-hooks for keeping the shed open. The pattern-chain controls the jacks in the usual manner.

193,783. SHUTTLE-BOX MOTIONS FOR LOOMS. John Shinn, Philadelphia, Pa.

The anchor-shaped lifters act upon studs projecting laterally from the oscillating lever, and thereby determine the position of the shuttle-boxes. Each lifter is provided with a pivoted catch, operated by a lever connected with a pattern mechanism. A yielding lifting-bar engages with the selected catch, thereby raising the corresponding anchor lifter, and placing in position the required box.

193,791. BRAIDING-MACHINES. A. Wietlisbach, Paterson, N. J.

The carriers are of the same diameter, and all are provided with four notches except the "returns," which have five. They all revolve in equal times by means of suitable gearing. They are also removable and capable of having their places supplied by blanks or "dummies," thus allowing the course to be broken or divided, for forming flat braid of different widths, or tubular braid or hose.

The combination, in a braiding machine, of the series of interchangeable notched spindle-carriers and blanks with actuating gearing, substantially as herein shown and described, whereby flat braids of various sizes, or tubular braided goods or hose, may be formed, substantially as set forth.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, SEPTEMBER 8, 1877. NO. 10.

PIVOT BRIDGE OF THE ANSTERDAM, UTRECHT AND COLOGNE RAILWAY.

The illustration given herewith is "Levytyped" from *Knight's Am. Mechanical Dictionary*, and represents the Swing Pivot Bridge of the Amsterdam, Utrecht and Cologne ailway over the Yssel, near Vestervoort, Holland. It shows the swinging span, gate-keeper's house, land spans for carrying off water at spring floods, ice breakers in the stream and on the lowlands. In the distance are the dunes of the coast.

THE METRIC SYSTEM.

A Familiar Explanation and a Popular Suggestion.

When the pound sterling as a unit of value in this country was, with its divisions into shillings, pence and farthings, abolished and Congress declared the Spanish dollar to be the monetary unit, dividing it into tenths, hundredths and thousandths, the reform was far more important than its most ardent advocates predicted. This unit is, with but slight variation, that of the whole American continent north and south. In China and many of the commercial ports of the East it is the chief standard of trade values. The five franc piece of France, Belgium and Switzerland in value closely approximates to it, nor is there any reason to doubt that all the African and Australian colonies of Great Britain, imitating their thriving American sister, Canada, will adopt it and thus constrain the slow-moving mother country to do so. When the value of the German thaler, hitherto so frequently variable, comes to be finally fixed, there is good ground to hope that it will be made equal to the Spanish-American unit, and among the reforms contemplated by the heir apparent to the Russian throne, upon his accession, that of the currency of his country has, it is said, already a place. There is indeed reason to anticipate the adoption at no distant day of our monetary unit by the whole civilized world.

At home, our boys and girls learn the table

10 mills.....	1 cent.	10 dimes.....	1 dollar.
10 cents.....	1 dime.	10 dollars.....	1 eagle.

in a few minutes. The time saved in study to all the children in the United States, by the substitution of this table for the English, is so vast in amount as to be worthy of calculation by a committee of social science philosophers, and statisticians, and to that body we respectfully refer it. How much time the substitution has saved to the millions of our people who have used it, as well as how much is saved annually by its use, are questions too difficult of solution, we fear, even for the wise body aforementioned.

Now, why not have our tables of weights and measures as simple as our table of coinage, instead of the present cumbrous system which came to us from England and is worthy only of the dark ages. No wonder the school boy is puzzled over the pennyweights, scruples, roods, rods, poles and perches; the two kinds of drachm, pound and ton, the three kinds of bushel, and the four kinds of gallon, quart, pint and gill. No wonder, despite his daily chanting in concert, that he spends years in trying to learn them in the public school. If we had a decimal system of weights and measures he would learn his tables in a day. Calculate, oh! sage philosophers, if you can, how much time for other studies the adoption of such a system would give annually our dear American little folks!

Now France formerly had a system about as bad as ours, but she abolished it many years ago, and adopted one which is a model of scientific simplicity. Then why not introduce it into this country and Americanize it. The reason we heard urged for not doing so is, that the American people would never learn the French names! To this we reply that but few of the French names are necessary. We may enjoy all the advantages of the French system and use our own names for its units, just as a man may talk about his Paris hat without calling it his *chapeau*.

Every intelligent reader knows that a French scientific commission laid down accurately on a meridian what engineers call a "base line," that from this the commission determined with great precision the length of a direct line on the earth's surface from the equator to the pole, that the length of this line is the same on all meridians, that one ten millionth part of this line constitutes the French standard of length called a *metre*, and that the metre is divided into tenths, hundredths and thousandths. So admirable is this system of "long measure" that scientific men of all nations have approved and adopted it, and the governments of Holland, Italy, Switzerland, Spain, Belgium, Chili, Brazil and other countries, have introduced it. So too would ours, it is said, but for the formidable French names! Let us then open the way for its introduction here by removing some of these stumbling blocks. Let us begin by giving to the French standard of length the name of that measure of our own to which it is about equal. Now the metre is just a little longer than the English yard. It is less than a yard and a tenth ;* so near that it might be adopted under the name of the *new yard*, and so declared by Congress. The term "new" being employed solely to distinguish it from the present English yard would be required only so long as both

*39,37079 inches.

systems continued in use. As soon as the people became accustomed to the reformed system, they would drop the distinctive term. To make our table of long measure as simple as our table of coinage, we must divide our unit, as the French do, according to the decimal system, borrowing from the latter table the words mill and cent, using them as prefixes, and adding to each a vowel for the sake of euphony, thus:

Ten milliyards ..... one centiyard.
Ten centiyards ..... one deciyard.
Ten deciyards ..... one yard.

Not long could our barleycorns, inches, and feet stand before so simple a system as this. Equally short lived would be our terms for greater lengths—rod, pole, furlong, league—if, following the same ratio, we extend the table sufficiently, using equally expressive numeral prefixes and calling a thousand new yards a mile. We use these prefixes in daily conversation, as when we speak of the *ten* commandments as the *deca*logue, and of the sacrifice of a *hundred* oxen as a *heca*tomb.

Is it probable that the American people would take a long time to learn to call ten yards a decayard or dekayard, and a hundred yards a hecayard, or to make the denomination more distinctive, a hectoyard? We think not, and at the risk of being charged with repetition, give the complete table of

LONG MEASURE.

10 milliyards	1 centiyard.	10 yards	1 dekayard.
10 centiyards	1 deciyard.	10 dekaya ds	1 hectayard.
10 deciyards	1 yard.	10 hectayards	1 mile.

The mile of a thousand "new" yards is very nearly five-eighths of an English mile, and is the same as the *kilometre*, the denomination in which the French engineers express the length of their railroads. In our next we shall treat of the new cubic measure and the new weights of the metric system.

A. L. K.

THE MANUFACTURE OF WHITE LEAD.

White lead has been employed as a painter's pigment for centuries, and still retains, by virtue of its dead whiteness and covering qualities, its superiority for this purpose over every substitute that has been proposed for the purpose of supplanting it. It would be very desirable if a substitute of equal value could be discovered; for, as is well known, painters and others engaged in handling it are liable to certain distressing forms of lead-poisoning—lead colic; and the color itself, though a most perfect dead-white when freshly applied, gradually blackens with age. But up to the present time nothing has been brought forward, save possibly zinc white, that can rival it; and the zinc white, though not liable to blackening by contact with sulphurous gases, is nevertheless so much inferior to the lead in covering properties that it has not seriously impaired its popularity or diminished its consumption.

The common method followed in manufacturing this product is based on the phenomenon that metallic lead, when subjected at a suitable temperature to the action of acetic vapor, carbonic acid and atmospheric oxygen, is converted into a basic carbonate, the "white lead" of commerce. An outline of the process as commonly carried on is given in what follows:—Large rectangular spaces are provided, walled in with brick or masonry, in which pots of acid (vinegar) containing coils of sheet lead are piled in stacks. These pots have an interior ledge which supports the coils. The stacks are constructed as follows:—First comes a layer of dung or tan-bark, then acid-pots, then lead plates, and then boards. Each pot is glazed, and contains about a gill and a half of acid and a roll of lead. About a thousand to twelve hundred of these are placed on one floor. This arrangement is repeated, alternating dung, pots, lead sheets and boards. An average stack contains about fifty-three gallons of vinegar and twelve tons of metal.

The explanation of the operation of this system is briefly as follows:—By the fermentation of the dung the temperature of the stack is considerably increased, the acid evaporates, and its vapors, with the coöperation of atmospheric oxygen, produce. by contact with the metal, a basic acetate of lead. This compound is speedily decomposed by the action of carbonic acid, which is evolved in the fermenting mass, and in this manner the production of carbonate of lead goes on slowly but uninterruptedly. The slowness of this process, though in one sense a disadvantage, has an offsetting advantage in producing a very superior product. The carbonate produced in this way is in a very minute state of division, and possesses an opacity and covering properties, in virtue of this fact, which distinguishes the paint made by this process from that made by precipitation, &c., in which the operation, though far more rapid, affords a product having larger particles, and hence less covering power, pound for pound, than the other. When the operation has continued sufficiently long to have effected the conversion of the entire metallic contents of the stack—which involves a period of four or six weeks—the operation of unsealing commences. This was formerly performed by hand, and was extremely unwholesome from the fact that the air about the operatives was loaded with minute particles of the lead. The stripping of the plates is now done by machinery. The plates are reduced to a powder by rollers; this powder is moistened and ground by millstones; from these it passes out, in the form of paste, into suitable vessels, and is then dried in the drying-house for a number of days. When dried it is in the form of cakes, which are either packed up ready for the market, or they are again ground, made into paint, and mixed with from 8 to 10 per cent. of oil.

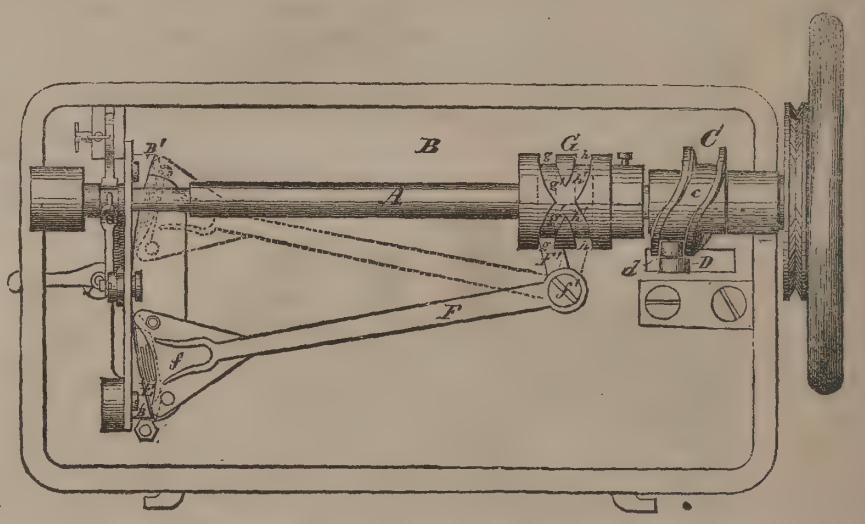
The usual practice, we believe, is to make the paint at once, which is not only a convenience to the user, but saves the painter the risk attendant on the manipulation of the dry carbonate. Numerous modifications of the above process are in use; but as they are based essentially upon the same chemical reactions, they need not be specially introduced in so brief a resumé as this.

The process of Thénard, which is largely employed abroad, however, is quite different, and is worthy of description. He produces a solution of basic acetate by dissolving litharge (oxide of lead) in rectified wood vinegar, then leads carbonic acid through the solution, by which a partial precipitation of the lead as carbonate is effected, a neutral acetate remaining in solution. This solution, after the removal of the precipitated carbonate, is again treated with litharge, producing fresh basic acetate, through which carbonic acid is passed as before, and so on, the process being continuous. As in the case of the first-described process, there are also numerous modifications of this, but all depend in principle upon the above-named reactions. The manufacture of white lead directly from galena—a native sulphide—has been successfully accomplished in this country, and bids fair to become an important industry. It is made also, in some localities, from the sulphate of lead, which is a by-product in the manufacture of acetate of alumina. It is produced by passing a stream of carbonic acid gas through the basic chloride of lead, formed by treatment of litharge with common salt.

White lead should have a pure white color, without taste or smell. Its covering properties, as before noticed, depend very much upon the manner of its manufacture, that produced by the precipitation method having a somewhat granular texture, and inferior in this quality to that produced by the Dutch method.

It should be noticed, finally, that, like many other manufactured products, the white lead of commerce is frequently adulterated. The commonest adulterant is barytes (heavy spar), which is added at times to the extent of 30 to 70 per cent. This form of adulteration must be quite profitable, as the barytes is heavier than the white lead, and very cheap. It is unnecessary to state that the quality of the lead is notably impaired by this adulteration, as it possesses no covering properties. Other adulterants, though less commonly used than barytes, are the sulphate of lead, witherite (carbonate of baryta), chalk, gypsum, and terra alba.

Pure white lead should dissolve completely in dilute nitric acid, and the addition of an excess of caustic potassa to this solution should give no precipitate; should any occur, it is most likely chalk. Should anything remain undissolved in nitric acid, it indicates the presence of heavy spar, gypsum, or sulphate of lead. W.



SHUTTLE-DRIVING MECHANISM FOR SEWING MACHINES.

The invention* described herewith relates to that class of shuttle sewing machines operating with a double-pointed shuttle, the movements of which are so timed with reference to the needle that it will pass through two successive loops of the needle-thread in shooting it once back and forth. It is claimed to equalize the power required to drive the machine by means of mechanism which will move the needle up and down while the shuttle remains inactive, and then shoots the shuttle in one direction during the time of rest of the needle.

As shown in the engraving, the driving shaft *A* is mounted on the base-plate *B* of the machine, and carries near the driving wheel a cam, *C*, in the groove *c*, of which an anti-friction roller *d* plays, the groove being of such a shape that during the rotation of the cam it will oscillate the needle-arm so as to move the needle once up and down, and then holds the arm stationary while the cam completes its rotation.

The double-pointed shuttle of the machine is supported upon a plate *f*, situated at the extreme end of the long arm of the bent lever *F'*, which is pivoted to the base plate of the machine at the point *f'*, and the short end *F''* of which engages in the cam *G* by means of a swiveling guide attached to its other extremity, and which is diverted once during each rotation of the cam from one annular groove into the other, and thereby swings the shuttle-carrying lever to and fro and causes the shuttle to pass across the path of the needle through the loop of its thread.

After the shuttle has been carried through the loop by the lever, the latter comes to a stand still, and remains at rest while the needle makes an up and down stroke, after which the guide is forced into the other annular groove of the cam *G*, and returns the shuttle to its first position, again passing through a loop of the needle thread, and so continuing with every revolution of the cam. The respective actions of the cams *C* and *G* are so timed that the movements of the needle and the shuttle will be approximately successive and not simultaneous.

The rear side of the double-pointed shuttle bears against studs or projections on the plate *f*, while its front side bears against the segmental side of the bar *B'* on the bottom of the base plate. Since the base plate is perforated, in order that the shuttle can be reached from above, a pivoted latch is employed to hold the shuttle in position in case of the slide covering the opening referred to should accidentally be withdrawn.

It is claimed that, by means of the mechanism described, the power required to operate the machine will be equal throughout the entire rotation of the driving shaft, and the machine will in consequence run evenly and slowly. O.

* Patented by Samuel M. Stewart, New Harrisburg, Ohio, and manufactured by J. M. Perdue & Co., Minerva, Stark Co., Ohio.

OMISSION TO CREDIT.—The *American Builder*, for September, prints without credit to us Mr. Haug's article on Saw Making, as carried on at our leading Saw Works.

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WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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WM. H. WAHL, } Editors and
R. GRIMSHAW, } Proprietors.

January 10th, 1877.

THE COMMON SENSE BASIS.

The course of this journal has been one entirely avoiding questions of politics. In this the editors have been guided by two principles: first, that this is not a political or a newspaper, but one for the advancement of theories and the dissemination of facts relating to technical subjects; and second, that there is, in any case, already too much politics in the world. But there are some things perhaps well worth considering, in view of the utter failure of politics and politicians to evolve much system out of the confusion of the past few years, or to infuse any hope at all into the minds of manufacturers and tradesmen. It is really due the public welfare that a rebuke, sharp and unstinted, be administered by all concerned, to those advocates of theories and systems who have so long delayed that return to prosperity which now seems so near at hand.

In the first place, there has all along been too much talk and too little work; too much theory and too little experience to base it on; too much financiering and too little thrift; too much attempted artificial regulation proposed, and too little common sense advanced. The questions of protection and free trade have all along been argued and re-argued, hotly and heavily, with sophistry and appeals to passions and local interests; and pending the dispute, manufacturers have been held in such uncertainty as to be paralyzed. All the tinkering in the world will not be able to regulate tariffs so as to be just and even upon all alike; and if we are to have a tariff, we might as well fix it so as to do the greatest good to the greatest number, and have it remain constant for more than a few months at a time, so that we may know what to expect. Our tariffs are like our climate—no one knows whether to expect a drouth or a flood, and constantly we have been nursing our knees in the house instead of going out to work.

As regards the currency, it is a ridiculous sight to see one party clamoring for more and one for less currency; one wanting gold as a standard, one wishing silver, one desiring both. The fact of the matter is, that no amount of issuing or retiring currency will make us any richer; our wealth is governed by what we produce and what we buy, and so long as we as a nation buy more than we sell, we are going to be poor and in debt; and it is small consolation to one whether, when gold is 105, he owes $1000 gold or $1050 greenbacks; it all simmers down to the fact that for certain house-rent and viands and raiment and trips to the sea shore, he has not paid in work. As to whether gold or silver or both, or greenbacks, shall be the standard, what odds makes it? Congress may to-morrow determine that a gold dollar shall be worth two silver dollars, or *vice versa*; and if I and my friends decide that we will not accept one of the favored kind in lieu of two of the other, the legislation is wasted and ineffective. No legislation could effect a fixed relation of value between wheat and potatoes, because when the potato crop is bad (as it generally is, and we are served right for pinning our faith on such a worthless, waxy, tricky, unnutritious vegetable) potatoes will "go up."

The usury question is one of a kind with some other things that are tinkered with to the public detriment. Money-hire, like horse-hire, is worth what people will give for it; and the one will go up in times of stringency, just as the other does in camp-meeting time. The usury laws of most States simply offer premiums on lying and deception, and dishonest evasion of honest obligations. There is no doubt about it that our legal rate of interest (generally six per cent.) which served well enough when our soil was virgin and our manufactures new, is now too high for most sections of our country, and causes that great curse of our country—over-trading on small capital.

The "capital and labor" antagonism never existed in reality. It is the old story of the hands and the stomach—when the hands "struck" against the pampered stomach, that "did all the eating and none of the work," they cut off their own supplies as well as those of the stomach, and the whole body suffered for nourishment. Capital desires employment just as much as labor does, and more. The capitalist with his hundred thousand dollars and the laborer with his hundred willing muscles, each needs employment, with this advantage on the part of the laborer, that he can almost at a moment's notice apply his muscles to any one of a dozen employments, while the capitalist's shekels are tied up in one place and cannot be quickly re-invested when business gets dull in any one line.

Concerning over-production and under-consumption, and the rest of the foolish talk that leads "statesmen," so called, to evolving theories from the depths of their inner consciousness—there never was any such thing as general over-production. There has been special over-production, and there always will be, just as there will always be big peach years, and great corn years, and remarkable potato years. The remedy simply is this, when there has been over-production in one trade or place, to change or move. The iron and coal industries were found to be very profitable, and hundreds of thousands of hands and millions of dollars of capital were put to work getting out iron and coal. When this demand lessened, the common sense solution of the problem would be for the hands to go to work raising something else that *is* needed, and for the capital to take care of itself the best way it could. Instead of which, capital has been trying to *hocus-pocus* affairs, when they would not be *hocus-pocussed;* and labor has been trying to force capital to pay more for a day's work than the finished product would bring.

The production and consumption matter has been arranged satisfactorily since the creation. Ever since

"Adam delved and Eve span,"

there have always been just as many hands as there were jaws—no more, no less. The bounteous earth, when tickled with a hoe, has ever laughed with a harvest. Agriculture has never been overdone; and the pastoral pursuit, but seldom. The farmers in the fertile valleys of Pennsylvania complain that the mines near them have drawn off their labor; the mines complain that they are overcrowded and the miners are underpaid. Common sense would dictate that some miners should turn farmers. The savings which supported these deluded men during strikes would have carried them to where their labor would have been rewarded.

Some find in the increasing use of machinery danger to the laboring class. Such a supposition is an absurdity. If a laborer has a machine which will save him an hour's work, or two hour's work, a day, it simply gives him that much time for self-improvement or self destruction, just as he chooses to employ it; and if he works the extra hours, he can earn in them comforts otherwise beyond his reach.

We respectfully submit that all the problems of the day may be much better settled by a due regard to common sense than in any other way. No amount of borrowing or stealing from one pocket to put in the other, ever enriched a man, nor can it enrich a nation. The national finances are like your finances, or ours, or any one else's; industry and thrift need no artificial aid. But it seems to us strange that men who cannot manage a corner grocery business of $5,000 a year should, on being elected to legislative bodies, attempt to wrestle with great financiering problems. It is such men and such foolishness that has kept us poor during the past few years.

Just now it seems impossible to shoot a gun in a crowd without hitting a man who has a theory of the finances, as a remedy for all the ills which laziness and roguery, and incompetence, and ill-judged investments, and loud-mouthed demagoguery, and financial tinkering, have brought upon us.

We beg to suggest that common sense, and not financiering, is the only thing to help us out of our troubles; and that the laws of supply and demand, if let alone, will take care of themselves. G.

MANUFACTURE OF BEET-SUGAR.

BY G. BARBIER.

CONDITIONS TO BE FILLED FOR ESTABLISHING A BEET-SUGAR FACTORY, AND THE RESULTS THAT CAN BE REALIZED.

The beet-sugar industry is developed in France under different forms. Sometimes cultivators working great extents of land, or an association of cultivators, construct sugar-factories and treat the beets which they produce. Sometimes sugar-makers establish themselves in favorable localities, without cultivating the beets themselves, and work the beets furnished by the cultivators who surround them. This last combination, which has the advantage of greatly simplifying the operation, is the one now almost altogether in use in France, the necessary capital for the establishment of perfect factories being quite considerable, especially if the factory is placed on a sufficiently large scale to carry on the industry in the proper manner. But in order that a factory could be advantageously established in a locality, it is necessary to meet with certain conditions that are not always met with.

Topographical Conditions.—The locality selected for the construction of a sugar-factory should be at the junction of roads leading in different directions, but all converging to a central point where the factory should be placed. It is convenient to place the factory, if other exigencies permit it, at the intersection of different means of transport (roads, canals, railroads, &c.), in order to facilitate an abundant supply from the various points, the transportation being the principal difficulty for the supply of the factory. The best locality for the factory should be in a valley, for the following reasons:

First. Because transporting the beets from an elevation to the factory would be less expensive, and the cultivators could supply the manufacturer from a greater distance.

Second. Because in the depressions of the valleys there are generally water-courses that are very necessary in the operations of the factory, which remove the residue and the water of condensation, to get rid of which is sometimes a great inconvenience and difficulty.

Thus the best topographical point for the erection of a sugar-factory would be the intersection of several ways of transportation in a valley having access to the plains by means of a slight inclination, in close proximity to a river and railway.

Agricultural Conditions.—The following conditions are indispensable for the successful establishment of a beet-sugar factory:

First. Land of good quality, with permeable subsoil.

Second. A prospect of six hundred to eight hundred acres of beets—a certainty of a three hundred or four hundred acre product. Beets raised upon prairie or swampy soil produce very little sugar. Lands that have been lately cleared of trees—that is to say, within

twelve or fifteen years—produce beets containing many peculiar chemical salts. These salts remain in the juice, and produce an exaggerated specific gravity above the saccharine richness of the juice. The best lands are those which have a light and deep soil, with calcareous subsoil.

Manures.—The manures which are most injurious to the quality of the beets, if used in excess, are human manure and guano. These cause ammoniacal products which frequently lessen the per centage of crystallizable sugar, and always render the extraction of the sugar more difficult. The manure of sheep has the same bad effect, and it is therefore that in certain regions it is prohibited to cultivate sugar-beets first on land which has received a dressing of this manure, unless a crop of other produce has been raised upon it.

Price of Beets.—The price of beets is sixteen to eighteen francs—equal to $3.20 to $3.60—per ton.

Pulps.—The pulp of the beet is excellent for feeding cattle. The cultivators estimate it as better than any other fodder, and the quantity of pulp from an acre or beets is equal in weight to any other fodder that could be raised.

In the cultivation of beets there is a double profit. After the juice has been extracted, the pulp—at least 15 or 20 per cent. of the beets—is sold to the farmers for ten or twelve francs ($2.40) a ton. The proportion of pulp varies according to the more or less powerful means of extraction.

Seeds.—The seeds of the beet should be furnished by the factory, to insure the cultivation of those that furnish the best yields with the greatest quantity of sugar, in preference to those which would bring uncertain returns from the lands with less percentage of sugar.

Water.—The factory should be established where one thousand to two thousand litres of water per minute would be at its disposal. This large quantity of water is required for the cleaning of the beets, for the scouring of the apparatus and factory, and, above all, for the condensation of the vapor produced during the concentration of the juices and syrups.

For a factory working one hundred and fifty tons of beets daily, about 120,000 litres of water must be evaporated. This vapor should be condensed by an injection of cold water,* which is extracted by means of pumps.

Fuel.—A well-established factory requires from 200 to 240 pounds of fuel per ton of beets worked. The coal used in the fabrication of beet-sugar is about one-fifth of the entire cost of manufacture, and it is important to have it of good quality and low price. It would not be wise to establish a factory where the coal would cost more than twenty-five to thirty francs ($5 to $6) a ton.

Manual Labor.—A sugar-factory with a working capacity of 150 tons of beets per diem employs 250 men, women, and children, of which a part work by day and a part by night.

Expenses of Constructing a Sugar-Factory—The Required Capital.—To establish a factory with accommodations for working 15,000 tons of beets in a season of one hundred days requires—

First. The buildings and estate	250,000 fr.	=	$50,000
Second. Machinery and apparatus	450,000 "	=	90,000
Third. Transportation and erection of machinery, &c.	20,000 "	=	4,000
	720,000 "	=	$144,000

In addition to the above, a capital of at least 80,000 francs ($16,000) would be indispensable to the enterprise—

First. For incidental expenses	30,000 fr.	=	$ 6,000
Second. Capital in hand	50,000 "	=	10,000
	80,000		$16,000

Expenses of Fabrication.—A factory of the above capacity would annually consume—

Fifteen thousand tons of beets at 16 fr. a ton	240,000 fr.	=	$48,000
Eighteen hundred tons of coal at 25 fr. per ton	45,000 "	=	9,000
Manual labor at 4.50 fr. per ton of beets	67,500 "	=	13,500
General expenses at 2.50 fr. per ton of beets	37,500 "	=	7,500
Animal charcoal at 0 fr. 30 " "	4,500 "	=	900
Filtering, &c., bags at 2 fr. " "	30,000 "	=	6,000
Oils and grease at 0 fr. 20 " "	3,000 "	=	760
Lime at 0 fr. 60 " "	9,000 "	=	1,800
Machinery repairs at 1 fr. " "	15,000 "	=	3,000
Transportation at 1 fr. " "	15,000 "	=	3,000
Incidental expenses	20,000 "	=	4,000
	487,300		$87,460

Returns.—The returns vary according to the more or less saccharine richness of the beets.† The minimum of richness can be taken at 5 per cent., and the maximum at 6 per cent. At 5 per cent. the returns would be 750 tons of sugar:

Sugar of first quality, 560 tons at 750 fr. a ton	420,000 fr.	=	$84,000
Sugar of second quality, 140 tons at 550 fr. a ton	77,000 "	=	17,400
Sugar of third quality, 50 tons at 450 fr. a ton	22,500 "	=	4,500
Pulp, 270 tons at 100 fr. a ton	27,000 "	=	5,400
Molasses, 380 tons at 120 fr. a ton	45,600 "	=	9,120
Returns	592,100 fr.	=	$118,420
Expenses	487,300 "	=	97,460
Profit	104,800 fr.	=	$20,960

At 6 per cent. the returns would be 900 tons of sugar:

Sugar of first quality, 675 tons at 750 fr. a ton	506,250 fr.	=	$101,250
Sugar of second quality, 165 tons at 550 fr. a ton	90,750 "	=	18,150
Sugar of third quality, 60 tons at 450 fr. a ton	27,000 "	=	5,400
Pulp, 270 tons at 100 fr. a ton	27,000 "	=	5,400
Molasses, 350 tons at 120 fr. a ton	42,000 "	=	8,400
Returns	693,000 fr.	=	$138,600
Expenses	487,300 "	=	97,460
Profit	205,700 fr.	=	$41,140

That is to say, 15 per cent. of the capital invested in case of a return of 5 per cent., and 25 per cent. in case of 6 per cent.

This result may be further increased by working the factory more than one hundred days. By working 125 days, 20,000 tons of beets could be treated, which would raise the profits of the factory between 150,000 fr. to 250,000 fr., according to the saccharine richness of the beets. Should this happen, as it is often likely to, it should not be taken as a rule, but as a compensation for an unfavorable season, when a poor crop lessens the supply of the factory, and the returns become less.

In a future article we will treat of the cultivation of beets.

* The required quantity of water is equal to twelve times the weight of the beets.

† Percentage obtained in several factories during 1872-73:—*Aisne*—Annecy, 5.60 per cent.; Noyaut, 5.55; Pommieres, 5.60; Fismes, 5.80; Flavy, 5.60. *Oise*—Villeneuve, 5.70 per cent.; Barbrie, 6.60.

HATS AND HAT-MAKING.

II.

After the "hat-body" has been formed as described in our last issue, it is driven into a heated mould by means of a liquid introduced beneath an elastic diaphragm, and which presses the body into the mould, as shown in Fig. 5. After being pressed, the felt body is dipped into boiling water and its nap drawn out or carded by means of a small hand-card.

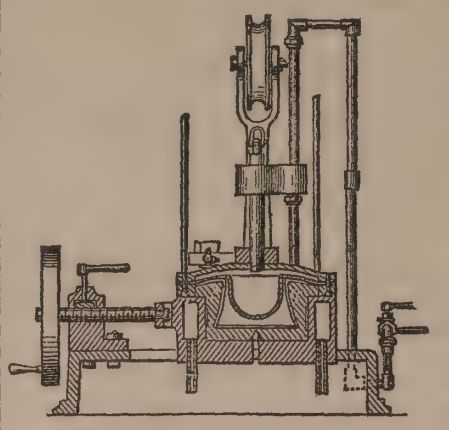


Fig. 5.—Hat-Mould.

The so-called "pouncing"-machine, shown in Fig. 6, is purposed for equalizing the surface of the hat. It consists essentially of rollers or "pouncing"-cones covered with sand or emery paper, and which are revolved rapidly in contact with the surface of the hat, and the projecting fibres thereby ground off, thus making the felt surface smooth and even. In the drawing the cones are mounted on shafts which have their bearings in a revolving disk in connection with a swivel-plate and an adjustable revolving block on which the hats are presented to the pouncers. By the combined action of the feed and pouncing-rollers, the brim is subsequently revolved automatically and operated upon by the pouncing-cones.

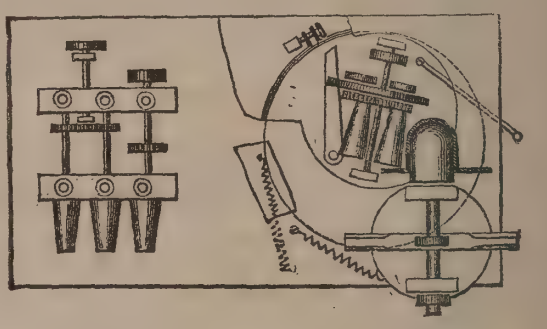


Fig. 6.—Pouncing-Machine.

Figs. 7 and 8 represent Simonet's pressing-machine, Fig. 7 being a sectional view of the steam-heated mould.

The conically-shaped hat-body or cone is placed on a heated mould, *w*, over which fits a dome whose lower edge is an elastic membrane, which assumes the shape of the hat; water is forced into the dome, and compresses the film *o* on the body and forces the latter on the mould. *ff'* are the force-pumps by which water is forced into the dome *b* through the bent pipe *g* and trunnion-tube *c*, which is on an adjustable bracket, *i*; the mode of connection allowing a vertical motion to the dome in closing and opening, and a horizontal motion when securing the foot of the dome in the ring *d* by means of a bayonet-joint attachment.

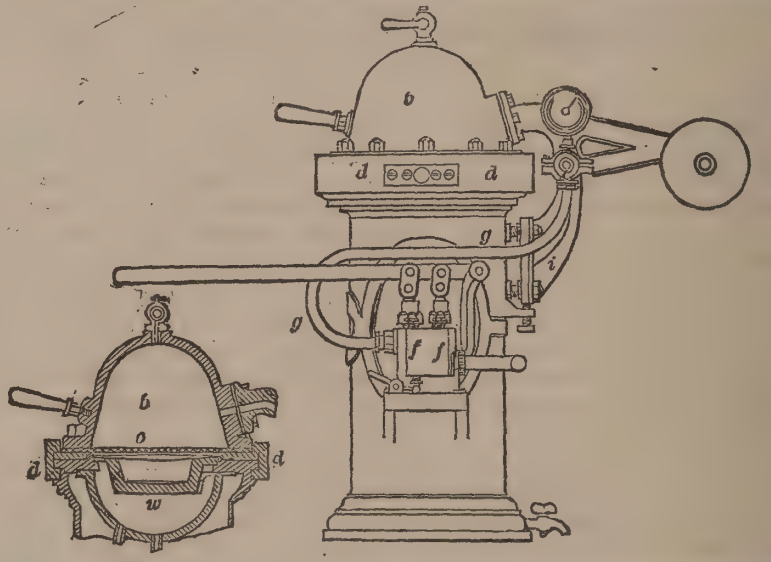


Fig. 7. *Fig. 8.—Simonet's Pressing Machine.*

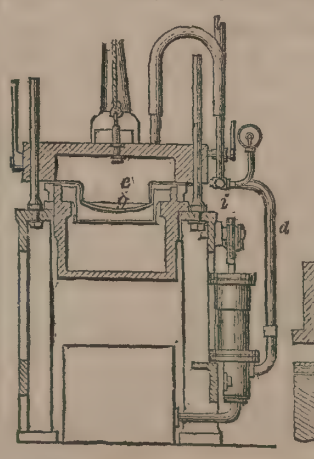


Fig. 9.

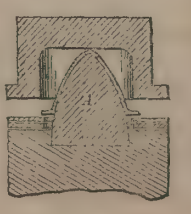


Fig. 10.

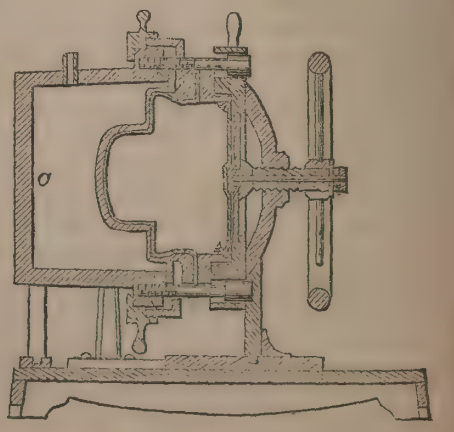


Fig. 11.

In Fig. 9 the hat *g* is shown undergoing the pressing operation, the pressure being derived by means of water forced into the dome *e* by means of the pump shown at the side of the machine.

Fig. 10 represents a sectional view of a hat-press in which a compressible block of rubber, *A*, is used to press the hat into the form, while the brim is held between yielding surfaces which preserve its shape.

In Fig. 11 is shown a pressing-machine, in which a paper, straw or cloth hat is brought into the desired form by being forced into a die by means of a plunger formed of a diaphragm of rubber distended by packing with sawdust; the die being heated by means of steam or hot water placed in the compartment *C*.

The so-termed hat-stretching machine, Fig. 12, consists of a series of radially arranged arms hinged to a head-block, *b*. The hat to be stretched is placed over the hat-cone *f* at the top of the machine, and held to the levers forming the same by means of the band *T*. The hat being in position, the head-block is raised and the arms separated by means of a lever shown in cut.

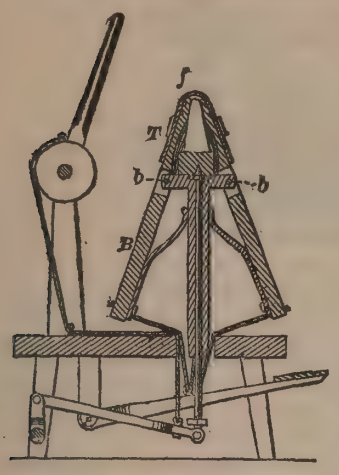


Fig. 12.—Stretching-Machine.

"In Fig. 13 the pieces *b d d'* are adapted to receive a cone supporting both the crown and brim portions. Rising with the cone, they carry it against two other sets of ribs or rollers, m^3 m^3, radially arranged, by which contact the body is crimped or stretched so as to have the requisite fullness to be brought into the hat form over a block. Jets of steam are introduced through the spindle to soften the fur and render it elastic. The ribs can be adjusted to suit varying sizes of hats."

The stretching and blocking machine, shown in Fig. 14, has the hat-cone fitted with a series of stretchers, which are surmounted by the block, and are carried up into the hollow former, which is made of radial ribs, making the crown square, and leaving the brim in a conical crimped condition, so as to admit of being stretched flat by the hand-process of blocking. In an improved form of machine the crown-stretchers have overlapping plates, so as to prevent break of continuity of the former at this point when the parts are distended.

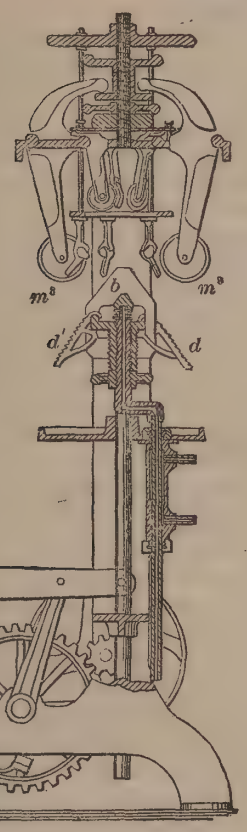


Fig. 13.

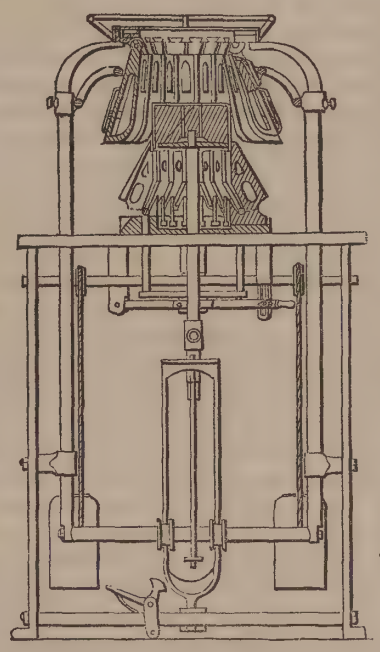


Fig. 14.—Stretching and Blocking Machine.

Fig. 15 represents a particular form of machine adapted for stretching the tip of the hat-cone so that it may be blocked flat. By depressing the foot-lever, the stretchers *l* rise and then expand, passing between the pendant arms *q*, and thereby stretching the tips of the body.

In the hat-weaving loom, shown in Fig. 16, the warp-strands for the hat are attached to carriers placed opposite each other in a circular series of partitions. The top of the crown is first woven, the warps being horizontal and moved to cross the path of the moving filling. When the top is completed, the warp-carriers are removed to the upper series of partitions, and a circular or oval plate at the bottom of a follower gauges the size of the crown; then, to weave the brim, the warp-carriers are removed to the lower series of partitions, the crown being fitted to a hat-shaped block. During the weaving, additional warps and warp-carriers are thrown automatically into action. The edge of the brim is finished by hand after the hat is removed from the machine.

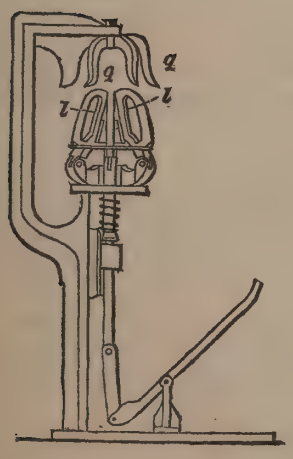


Fig. 15.

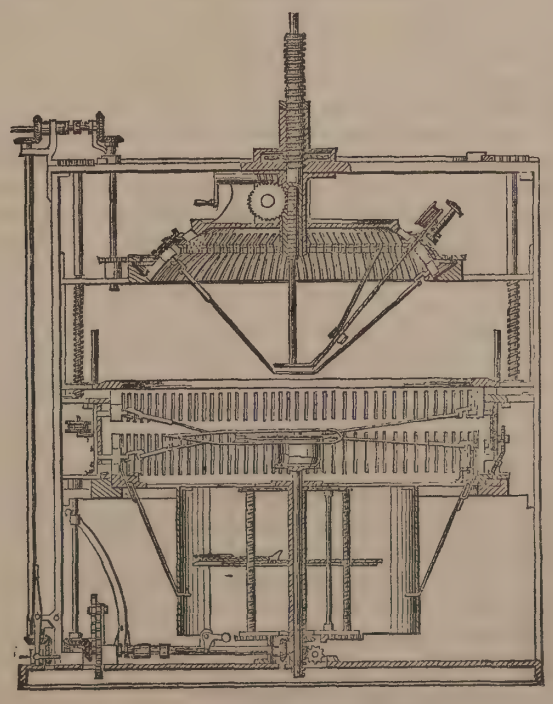


Fig. 16.—Hat-Weaving Loom.

The last operation to which the hats are submitted before being bound and ribboned for the market is performed by the machine illustrated by Fig. 17, or the ironing-machine. The function performed by this ingenious machine was formerly done by hand. The block upon which the unfinished hat is stretched is placed upon a spindle and rapidly rotated in contact with hollow irons heated by means of a gas jet, steam, hot water, or slugs placed in their interior. The irons are pressed against the hat by means of springs or weights attached to levers, as shown in the illustration. The under-brim of the hat is either finished by hand or brought in contact with the irons of the machine by inverting the block. In the improved form of this machine the spindle is so placed as to allow an iron being placed below the brim to iron the lower side simultaneously with the ironing of the crown and upper side.

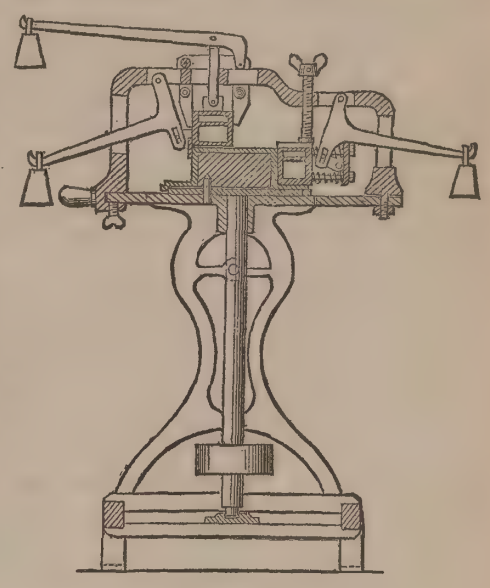


Fig. 17.

O.

GALVANIC BATTERIES.

We make the following very instructive extracts on this topic from the lately issued and admirable work on *Electricity and the Electric Telegraph*, by George B. Prescott:*

The observations made in 1789, by Galvani, that the legs of a prepared frog are convulsed when their muscles are connected with a strip of copper, their nerves with a strip of zinc, and the opposite end of the two strips are united, convinced Volta, after a great deal of experimental investigation, that these phenomena were due to electrical action. The result of Volta's researches established the fact that when two dissimilar metals come into contact they become electric, and the force of the electrical commotion depends upon the nature of the metals. This force acting on the point of contact of dissimilar metals is called electromotive force. It divides the electricities present in the natural condition of the metals, and forces from the point of contact the + fluid in one of the bodies, and the — fluid in the other, where they remain in a state of rest and tension, in an effort to unite again, until finally they find some means of coalition and equalization. All the metals as well as the carbons are good electromotors, but no two metals develop in connection with any other the same degree of electrical tension. Zinc, for instance, in contact with platinum, becomes more electric than when in contact with copper; and copper in contact with platinum becomes + electric, while in contact with zinc it becomes — electric. The following series of bodies is so arranged that any of them in contact with some other becomes electric, and each preceding body in this series in contact with the preceding body is + electric, while the succeeding body is — electric: + zinc, lead, tin, iron, copper, silver, gold, platinum, carbon, —.

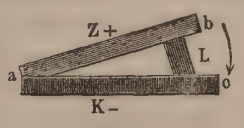


Fig. 1.

Galvanic Current.—When in Fig. 1 the zinc plate *a b* comes in contact with the copper plate *a c*, the + E of both metals gathers on the zinc plate, and — E on the copper plate.

Both electricities are in a state of tension or of desire to unite again, which, however, they are not able to do, owing to the inability of the source of commotion (the contact place *a*) to take the lead. Now, if we connect the zinc and the copper plate by a moist conductor L, for example, by a strip of pasteboard soaked in water, or in diluted sulphuric acid, or if we dip both contiguous plates in such a fluid, the union of both separated electricities takes place through this moist conductor, the + E flows from the zinc through the conductor in the direction of the arrow towards the — E of the copper, the — E of the copper on the contrary in the opposite direction towards the + E of the zinc, and the electric flow would at once cease were it not that in the continuing contact of the metals a source of an ever-new analysis of electricity were to be found. At the same moment that both electricities pass through the moist conductor and become equalized, the electromotive force produces at the point of contact *a* a new electric analysis, which likewise, however, becomes at once equalized again, to make room for a new tension.

In this apparatus, which is styled an open voltaic or galvanic circuit as long as there is no moist conductor, and a closed voltaic or galvanic circuit or a single galvanic element as soon as the moist conductor is put in, a continuous flow of both opposite electricities takes place in opposite directions. The flow of the + E proceeds from the zinc through the fluid to the copper; outside of the fluid it passes from the copper over the contact point to the zinc. This uninterrupted equalization of both electricities forms a continuous flow, which

* Published by D. Appleton & Co., New York.

is styled a *galvanic current.* When we speak of the direction of a galvanic current, we always mean the direction of the + electricity in motion for the time being, which follows outside of the fluid from the copper to the zinc.

Galvanic Batteries.—If, as is represented in Fig. 2, several compound pairs of zinc and copper plates are put up in layers, always in the same order, and between each pair a moist conductor is inserted, such as a disk of felt, cloth or pasteboard, so that the succession of the bodies arranged on each other from top to bottom is as fol lows :

Copper, zinc, conductor | copper, zinc, conductor

Copper, zinc, conductor | copper, zinc ; one end of the series terminating with zinc, and the other end beginning with copper, a current will flow when both ends are connected by a wire, and the more pairs of plates the series contain, the greater will be its electromotive force. The extreme ends of the series are called poles. The pasteboard disks are soaked in water, mixed with common salt or sulphuric acid, and thus allow an easier passage to the current than when they are moistened with pure water.

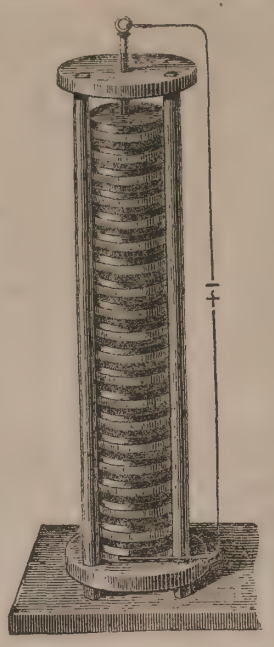


Fig. 2.

When a fluid is used instead of a moist disk, the battery has the form represented in Fig. 3. In each glass is a zinc and a copper plate, and each zinc plate of one of the vessels is connected by a copper wire with the copper plate of the preceding vessel. The poles of the battery, indicated by + and —, are both connected with closing wires. As is represented in the drawing by arrows, inside the cells the positive current passes from zinc to copper, and externally—that is to say, in the closing wire—from copper to zinc.

As electricity is also created through the contact of a metal with a fluid, the action of a voltaic battery will be plainly understood when it is granted that the seat of the force which creates the electricity is not only to be found in the contact points of both metals, but in the contact between the metal and the fluid ; hence some electricians have recently so enlarged upon Volta's theories in this respect as to admit, besides the creation of electricity through the contact of metals, still another similar force at the contact point of the metals and the fluids. Opposed to these are the advocates of the chemical theory, who contend that electricity in a galvanic element is created only by a chemical action which takes place between the fluids and the metals.

If both poles of a galvanic battery are connected through a conducting wire, the latter shows a succession of phenomena which may conveniently be arranged in five classes, to wit : 1. The phenomena of light ; 2. The production of heat ; 3. Physiological effects ; 4. Chemical, and 5. Magnetic effects.

The phenomena of light are perceptible even with a single galvanic element of large surface. If the extreme ends of the wires starting from the poles are brought together, as in Fig. 2, we perceive, when separated, if the ends have been previously amalgamated, a beautiful bright spark. The current which passes when the contact is made does not cease with the separation, but forces its way through the intervening air. If we take a battery of 40 or 50 elements and put carbon points on the extreme ends of the wires, there will appear between the points a splendid light, whose dazzling brilliancy blinds the eye. It is deserving of notice that, whilst frictional electricity has such an enormous tension that, under favorable circumstances, sparks will leap across the air to neighboring conductors, at a distance of 40 inches, we may place the poles of a very powerful galvanic battery to within $\frac{1}{20000}$ of an inch of each other without any spark passing over or the battery sending any current. The ordinary galvanic battery is, therefore, unlike the electric machine and the Leyden jar battery in respect to tension.

The production of heat by the galvanic current is likewise apparent, even in a single element of large surface, where a fine platina wire inserted in the closing wire becomes red hot. By means of a series of these elements, or a voltaic battery, this metal is easily melted.

The physiological actions of the galvanic current are manifested even by a single element in affecting the taste and the optic nerves. They appear in a far greater degree when the terminal wires of a powerful galvanic battery are seized by moist hands, causing an almost intolerable sensation, and burning in the arms and breast. Upon this fact are founded also the highly interesting experiments which are often made with galvanic currents on recently-killed animals and human beings.

The chemical actions of the galvanic current are, in their theoretical and practical relations, still more important, affording an insight into the nature and origin of the current, as well as of the construction of the galvanic elements. They are frequently used in electroplating, electrotyping and gilding, and also in telegraphy.

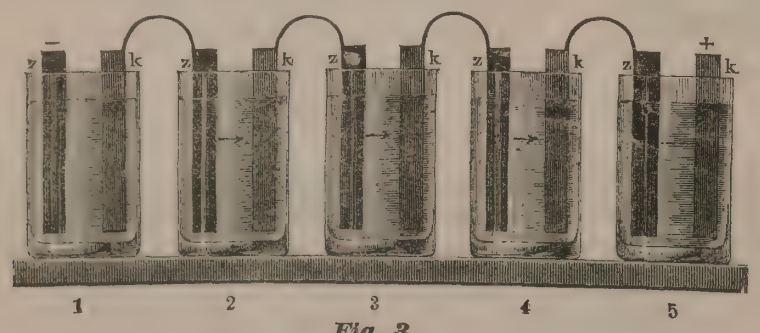


Fig. 3.

When, as in Fig. 3, a part of the conductor consists of water, its materials, oxygen and hydrogen, become analyzed by the action of the current. The oxygen attacks the zinc Z (the positive metal) and forms oxide of zinc ; the hydrogen accumulates on the copper K (the negative metal) and in a short time covers the plate. All the oxygen accumulates on the zinc, and all the hydrogen on the other metal. The same holds good also when, as is shown in Fig. 4, the current outside the battery passes through a fluid. If, for instance, the positive current enters through the closing wire E to plate L, made of zinc, platina, or some other metal, into the water A, and out again through the metallic plate D, then the oxygen accumulates at L and the hydrogen at D.

Hence it follows that the metallic surfaces of the zinc and copper become separated from the conducting fluid, and instead of the former metallic contact between the fluid and the plates, a contact of oxide of zinc and hydrogen sets in, and the original current very soon loses its strength, and almost disappears after a short time. The same thing takes place to a greater extent in the ordinary voltaic battery, because, owing to the more active analysis of the water which the stronger current produces, the oxygen unites with the zinc to produce oxide of zinc, and the hydrogen, in the form of small bubbles, covers the copper ; hence, instead of the original zinc-copper battery, we have a combination of far weaker electromotors, viz., zinc-hydrogen.

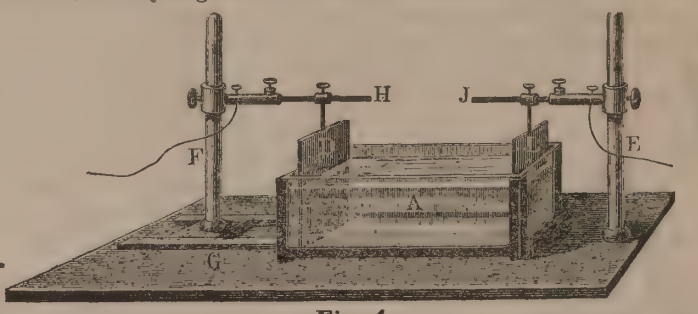


Fig. 4.

If we put in a vessel A, containing acidulated water (Fig. 4), two platinum plates, D L, and connect them with the pole-wires F E of any galvanic battery, the water between the platinum plates becomes likewise decomposed ; the oxygen is carried to the positive, the hydrogen to the negative platinum plate. As the oxygen here does not unite with the platina, both gases, the mixture of which is styled inflammable gas, rise at the platinum plate from the fluid. Several other compound bodies, like water, are decomposed by the galvanic current, and in this capability of the liquid conductor of being decomposed is to be found the principal reason for the unsteadiness of the earlier voltaic batteries.

In our next issue we will describe the various forms of sulphate of copper batteries.

THREADING OF BOLTS.

One of the most vexatious annoyances of the machinist, particularly in making repairs, has been the lack of uniformity in the pitch of screw threads as compared with the diameter of the bolts. The verb "to be" is used in its past tense in the preceding sentence, for there is hope that this annoyance is in process of removal by the general adoption of threads uniform in pitch and shape, and on a system of proportions between the thread and the bolt's diameter. Heretofore every shop had its own style of thread, and almost every workman had his pet pitch and grade, making his own taps and dies in sweet and careless independence of any system, being a law unto himself. The confusion of threads was still further enhanced by the adoption purposely, by some concerns, of fractional threads, with the intention of inducing a return of the article manufactured to the shop whenever in need of repairs. Generally, not the least attempt was made to maintain a proportion between the pitch of the thread and the diameter of the bolt, ten threads to the inch being used on bolts of one inch or of nine-eighths as frequently as on three-quarters ; and sixteen threads to the inch was the favorite pitch for bolts from one-quarter to five-eighths. Nuts were as frequently tapped by a taper tap, entered from both ways, as by a plug tap. That such a state of confusion was undesirable required no argument to prove, and a number of attempts were made to rectify it, generally by the adoption by some manufactory of a system for itself, or proposed by some writer on practical mechanics. It was evident, however, that no system would be generally adopted that did not bear the approbation of some universally respected authority. This authorization was secured in December, 1864, when a committee of ten practical mechanics, which had been formed eight months before, reported to the Franklin Institute what is known now as the United States standard. Having been approved by the Institute and adopted by the United States Government, the Master Mechanics' and Master Car-Builders' Associations, and by many manufacturing companies, there is a prospect that before many years it will become the general rule, and the day of confusion in screw threads be past. It is a matter for regret that a universal system had not been inaugurated rather than one of merely national extent ; but as the English had already adopted the Whitworth standard and style, and the French measurements were all decimals, it was probably not feasible to procure the adoption of an international system. On some accounts the Whitworth form of thread is to be preferred : it leaves the core or shank of the bolt stronger than any other, and is much less liable to receive injury from a blow ; but it is generally considered that these advantages are more than counterbalanced by the disadvantages of extra work in forming the threads on lathe-cut bolts and taps. The Whitworth style gives the top and bottom of the thread a semicircular form in cross section, so that, instead of the thread being sharp like the point of an ordinary screw cutting-lathe tool, it is convex on the top and concave on the bottom. The incline of the sides is the same as that of the United States system—sixty degrees ; but the United States standard thread does hot carry its V form to a point, but the top and bottom of the thread are square one-eighth of the pitch, so that the thread has the appearance of being not quite full. This form preserves the top of the thread of bolt and tap from injury from a casual blow, leaves the core of the bolt stronger than it could be if the V were cut to an edge, and prevents the frequent breaking of the point of the lathe screw-cutting tool which so often hinders the workman.

But the form of the thread is only one part of the requirements of a standard ; the proportion between the number of threads to the inch and the size of the bolt is fully as necessary to be determined. The following gives a comparison between the United States and the English systems :

UNITED STATES (FRANKLIN INSTITUTE) STANDARD.

Diameter of tap or bolt,	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
No. of threads to inch,	20	18	16	14	13	12	11
Diameter of tap or bolt,	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{8}$
No. of threads to inch,	11	10	10	9	9	8	7

Diameter of tap or bolt,	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2¼
No. of threads to inch,	7	6	6	5½	5	5	4½	4½

Diameter of tap or bolt,	2½	2¾	3	3¼	3½	3¾	4	
No. of threads to inch,	4	4	3½	3½	3¼	3	3	

ENGLISH (WHITWORTH) STANDARD.

Diameter of tap or bolt,	1/4	5/16	3/8	7/16	1/2	5/8	11/16	3/4	13/16
No. of threads to inch,	20	18	16	14	12	11	11	10	10

Diameter of tap or bolt,	7/8	15/16	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞
No. of threads to inch,	9	9	8	7	7	6	6	5	5	4½

Diameter of tap or bolt,	2	2¼	2½	2¾	3	3¼	3½	3¾	4
No. of threads to inch,	4½	4	4	3½	3½	3¼	3¼	3	3

• The United States system also determines the thickness and diameter of heads and nuts, square and hexagonal. But the demands of work for particular sizes and proportions of heads and nuts diminish the importance of this rule, and it is not always observed.

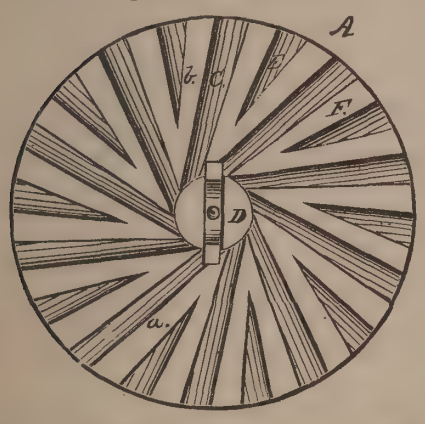
A system of sizes and pitches once adopted, it is apparent that the taps and dies can be better made by concerns which fit up specially for the work, and that is what this reform has brought about. Reliable and well-known manufacturers have undertaken the business, and furnish, at fair prices, the tools in the most handy form. For dies the solid style is fast taking the place of the expanding or movable dies, so that each die shall cut but one size of bolt, and shall make and finish the thread at one passing over the bolt; just as the tap cuts a thread for only one size hole, and cuts it at one operation. At first sight this looks, to a workman who has been accustomed to the old style screw-plate, as though the latter is by far the most comprehensive tool; but if one will consider that the die has a similar office to that of the tap, and should be as much a gauge of size, the use of the solid die appears to be correct. This system has been the one for gas and steam-pipe threading for years. As the dies are made the change from one size to another is easily effected, the same stock being used for dies cutting from four to six sizes, the die collets being held in the stock by a spring bolt, that is released instantly by the pressure of the thumb. If one of the threaded cutters or chasers should be broken, another may be put in its place without trouble or waste of time; and when dull, a moment's use of the grindstone or emery-wheel will sharpen the chasers without reducing their thread size. The size is determined so accurately in these dies that they are found very useful for dressing, gauging, and finishing a lathe-cut thread, the die being passed once over the thread. The work done by these dies is beautiful, the thread being cut entirely from the material of the bolt—not squeezed or raised up—so that when finished the thread portion does not calliper any larger than the uncut portion of the bolt. Adaptations of these dies to machines working by hand or power are made, and do their work with great rapidity.

JESSE H. LORD.

NEW MILLSTONE DRESS.

Patented August 15th, 1876, by Johnston K. Snavely, of Middletown, Pa. Specifications forming part of letters patent No. 181,015.

The engraving represents the running-stone, and the letters thereon indicate certain parts of the dress. Both top and bottom stones are provided on their grinding surfaces with ten or more leading furrows, *C*, at equal distances apart, which are in width the proportion of the diameter of the stones. They may be from two to four inches wide at the skirt or periphery, and taper to about one or one and a half inches at the eye, *D*, of the stone. There are ten or more triangular furrows, *E*, placed between the main furrows, *C*, which are of the same width at the periphery or skirt as those of the leading furrow, *C*, but tapering to a point about half way between the skirt and the eye, *D*, of the stone. Both leading and triangular furrows, *C* and *E*, are about one-eighth or one-fourth of an inch deep at the back, and taper to a feather edge, as shown. It is claimed that in this dress the lands *F* are so distributed as to perform as much of the work as possible near the eye of the stone, thereby saving power; also that the furrows thus arranged will discharge the feed in the quickest possible time after being ground.



The revolution which has occurred during the past few years in our American system of milling has left no department of the art untouched, but has made every step in the progress of flour making the object of close and scientific investigation. The millstone is the basis on which successful milling must rest. No matter how perfectly the wheat may be cleaned preparatory to grinding, or how carefully and elaborately the chop may be manipulated after it, all work will prove defective unless the wheat is subjected to burrs which have been dressed with reference to the work to be performed.

Of late years, millers have clearly recognized this fact, as evidenced by the increased attention and study bestowed upon the nature of the burr and the part it plays in the transformation of wheat into flour. Millers have examined closely into the action of the burrs upon wheat, and from the data thus gained have endeavored to devise methods of dress which should facilitate and improve the operation of grinding. The result has been a wide departure from the practice of our fathers, and a nearer approach to an absolutely perfect system of milling.

In grinding grain it is a great desideratum that the chop should be discharged as quickly as possible after it is ground, and the inventor claims that this object is accomplished by the arrangement of the furrows described above. It is also aimed to do as much of the grinding as is feasible near the eye of the stone, and thus to economize the power necessary to run the burrs. The distinctive feature claimed for this dress, however, is that, by grinding high, an increased amount of middlings can be made over ordinary dresses; and by grinding low, the amount of middlings produced is much less than with other dresses. The progressive millers of to-day are seeking every means to increase the yield of middlings, and a dress which claims to effect a perfect granulation is entitled to and will receive their attention.

The inventor claims and guarantees a saving of fifty per cent. of power in grinding all kinds of grain, making better flour and more of it from a bushel of wheat, also better meal from corn than it is possible to make with any ordinary dress when grinding to its full capacity; also that it grinds damp grain with equal facility, keeping cool all the time and under any speed of grinding; and in all cases, when properly applied, doing a larger amount of work with the same power than any other known dress. It does not require the skill of more than an ordinary miller or stone-dresser to apply it on a mill, and but a short time to make the change from the ordinary dress.

[The above description is largely taken from the *American Miller*, April, 1877.]

CHILLED CASTINGS.

In our investigations concerning the properties of the most important of metals, in its forms of pig-iron, steel and wrought iron, with their decreasing portions of mixed or combined carbon, we have considered the effects of varying the proportions of carbon, (1) by "cementing" wrought bars, (2) by decarbonizing pig by an oxidizing flame, or (3) by decarbonizing pig with an air blast, afterwards adding super-carbonized or temper metal, to bring the carbon up to the required percentage. The second process produces wrought iron or Siemens-Martin steel, according as the decarbonization is more or less thorough; the third process Bessemer steel, and the first gives us blister steel. The operations of squeezing and rolling give to the wrought iron a marked fibrous character. These operations are all performed upon the unshaped material. By packing manufactured wrought iron in a substance rich in carbon, and subjecting to heat, we have case-hardening or external steelification; and by packing iron castings in a decarbonizing material, and similarly heating, we produce granular malleable iron.

Besides these changes produced, (1) before manufacture, (2) after manufacture, we may effect a third class of changes *during* manufacture, by mixing with liquid cast iron, at the time of pouring, decarbonizing substances which give us castings of "doctored" material—"steel," so-called—for the manufacture of which there are innumerable patents and secret processes.

The presence of sulphur in any one of these metals tends to produce brittleness or "shortness" when hot; phosphorus causes brittleness when cold. Chromium, in proper proportions, gives a steel of extreme hardness, and silicon is claimed to produce the same effect. Besides all these varieties of metal, adapted to the many and varied requirements in construction, we may produce other results, without varying the proportion of the constituents, by regulating the tension and arrangement of their particles. Thus, frequent remelting of cast iron, and frequent piling and rolling of forged iron, give in one case fineness and density of crystals, and in the other fineness, length and parallelism of fibers. Alternations of temperature produce alternations in crystalline arrangement of steel; the sudden quenching producing, in both, increased tension and hardness, and delayed cooling relaxing that tension and softening the material. That this is the case, is evinced by the fact that a bar of cast steel becomes, when highly tempered, shorter, wider and thicker; a wrought steel bar becomes *longer*, but no wider nor thicker, as evinced by the measurements of Caron, (recorded in Barba's "Uses of Steel") herewith given:

CAST STEEL BARS.

	Natural Heat.	Red Heat.	After Tempering.
Length	20	20.32	19.95
Width	1	1.03	1.01
Thickness	1	1.03	1.01
Volume	20	20.557	20.351

ROLLED STEEL BAR.

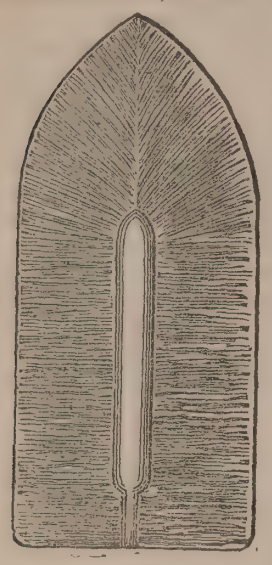
	Natural State.	After Tempering.
Length	20.	20.451
Width	1.51	1.51
Thickness	3.70	3.70
Volume	111.74	114.25

By governing the actual and relative rate of cooling of different parts of iron castings, we may produce at will a soft, dull, easily worked and granular mass, or one that is brilliant, hard, and highly crystalline, and we may produce tension in any part at will. Without actually varying the apparent structure of castings, we may put their several portions in various conditions of stress, desirable to control at will. In casting a spoked pulley in one piece, the arms and rim cool so much more rapidly than the hub, that there is a tendency to burst or split, this tendency being frequently resisted by making the arms *curved*. In casting large cannon, the interior would naturally cool later than the exterior, and be in less tension—a very undesirable state of affairs; as to resist the shock of explosion, the interior should be specially braced. To produce this effect, (which in cannon built up of wrought hoops or coils is done by properly proportioning the diameter of the successive rings) the interior of a cast gun is cooled by a water core, while the cooling of the exterior is delayed by fires built around it. Thus the interior, after being contracted in cooling, and drawing the exterior with it, is further gripped and put in tension by the later cooling and contraction of the exterior. So much for tension; let us now consider the question of structural alteration.

Noting an ordinary green-sand casting, we find, on working inwards, (1) a gritty

silicious surface, caused by mechanical adhesion of the sand in the mould; (2) a very thin vitreous coating or enamel, formed by the fusion of the mould sand, and which will ruin a good file; (3) a skin of very hard crystalline cast iron, not readily attackable with the file; (4) an interior that can be filed or turned "sweetly," and without great difficulty. The nature of the first two coats we have explained; the hard skin is caused by the rapid cooling of the metal, and the more granular interior is the result of more leisurely congealing. The crystalline structure, and the superior hardness of the skin proper, are due (as are the hardness and brittleness of tempered steel) to the rate of cooling. By casting against a good conductor (as iron) previously cooled, we effect a sudden cooling and crystallization, extending to a depth dependent upon the mass of the casting to be operated upon.

On breaking such a "chilled" casting, we note on its exterior an exaggerated skin, from ½ to 2 inches in thickness, composed of hard brilliant crystals, arranged in lines perpendicular to the surface of cooling; that is, the crystal lines are in the direction of the radiated heat rays. Cast iron shot are thus chill-cast, for the double purpose of securing the greater roundness of an iron mould, and of giving them extra hardness and increased penetration. We recently illustrated* a chilled conical shell, in which the crystal lines in the taper end were *curved*, owing to the mass being cast *point downwards*, and as it cooled, shrinking from the sides of the mould, and resting upon the point, which became a new surface competing with the sides for the abstraction of heat. We reproduce the cut.



SECTION OF CHILLED IRON CONICAL SHELL.

In the same article we alluded to the effect of these chill-lines in inducing fractures in given directions, and the practice of casting cannon with oval lengthwise section in the breech, so that the cooling lines might be radial from the centre of explosion, and we showed the cause of the fracture of the hydraulic cylinders at the Menai bridge, as having been their casting with flat bottoms at right angles to the bore.

Plowshares cast with the *under* side chilled, wear away on top, so that they have always a sharp, chilled cutting edge—this "self-sharpening" provision being similar to that of the enameled incisor teeth of squirrels..

Chilled castings are also used for axle boxes, iron wheel hubs (which are in effect rotary bearings), stamp-heads, heavy hammers, anvils, etc. But perhaps the two most important applications are in the manufacture of calender rolls and of car wheels.

G.

*Volume IV, page 62.

SCALE IN BOILERS.

It is a well-known fact, that a deposit of scale in steam boilers is fraught with great danger, rendering the plates, exposed to the action of the heat from the furnace, liable to be burned and cracked, and in many cases leading to destructive explosions.

But even if no immediate danger were to be feared, there would be an increasing loss of efficiency of the heating surfaces, in proportion as the deposit became thicker.

In M. Peclet's "Traité de la Chaleur," the following formula gives the rate of conduction, q, through iron plates, per square foot per hour in units of heat:

$$q = \frac{T^1 - T}{C + \rho x}$$

where T^1 and T are the temperatures on either side of the plate, C the coefficient of external thermal resistance, ρ the coefficient of internal thermal resistance, and x the thickness of the plate.

M. Peclet gives

$$C = \frac{1}{A\,(1 + B\,(T^1 - T)}$$

where A for dull metallic surfaces $= 0.7$
and B " " " $= 0.0037$.

Taking the temperature of the furnace at 1600°, of the water in the boiler at 300°, we have

$$C = \frac{1}{0.7 + (1\ \ 0.0037\ (1300)} = 0.2459$$

ρ for iron plate is $= 0.0096$, and x may be taken as 0.375 inches. Then

$$q = \frac{1300}{0.2459 + (0.0096 \times 0.375)} = 5210°$$

If the iron plates were covered with a scale a half inch thick, the formula would stand:

$$q = \frac{T^1 - T}{C + \Sigma\,\rho\,x}$$

where $\Sigma\,\rho\,x$ would represent the collective internal thermal resistance of the iron plate and the scale. Taking the coefficient of thermal resistance for the scale as $= 0.5$ we would have:

$$\Sigma\,\rho\,x = (0.0096 \times 0.375) + (0.5 \times 0.5) = 0.2536 \text{ and}$$

$$q = \frac{1300}{0.2459 + 0.2536} = 2692°$$

showing that the conductive power is reduced about one half by this deposit of scale.

But even where the deposits formed are not hard, or where this material is held in solution, injurious action on the plate, and a loss of evaporative power will be caused.

It is well known that the conduction proper of heat through a stagnant mass of liquid is very slow, and it is only by circulation and mixture of the particles that the heat can be rapidly transmitted and diffused through the entire mass.

Water saturated with such material is therefore rendered unfit for the generation of steam, on account of the resistance offered to the circulation and escape of the steam bubbles, and to the free convection of heat.

It will be seen how important it is not only to keep the boiler free from hard deposits, but also to keep the water clear from all such matter. J. HAUG, M. E.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

SECOND PART.—I.

LINK MOTIONS.

It is often required that steam engines should be constructed to run either forward or backward, as is the case with locomotives, marine engines, hoisting engines and others. Valve gears, by which this end can be accomplished, are called "reversing gears," and most of those now in practical use admit of a variation of the degree of expansion. The almost exclusive use of "Link Motions" for this purpose makes it of the utmost importance that steam-engineers should be perfectly familiar with the peculiarities of these most ingenious devices, especially since they can be proportioned to correct the difference between fore and return stroke occasioned by the obliquity of the connecting-rod.

The number of different link motions and other reversing gears admitting variable expansion is not small, but it seems that the two first inventions (the Stephenson, and the Gooch link motion) have stood the test for fitness and durability better than any of their followers. We shall therefore consider the theory of these two gears only, but it may be remarked that the operation of nearly every other reversing-gear can, in some measure, be compared with that of either of these two link motions.

THE STEPHENSON LINK MOTION.

This link-motion, the general arrangement of which is shown in Fig 24, is the one most generally used, especially on locomotives.

Two eccentrics I' and I'' are secured to the crank-shaft, and the ends P' and P'' of the rods of these eccentrics are jointed to the "expansion link" or commonly called, briefly, "link," which is a curved frame of wrought iron or steel, containing a sliding block B that is fitted into the slot of the link and is attached, by a joint, either directly to the valve-stem V or else to a rocker by which the slide-valve is moved. Two of the more usual forms of the link are shown in Figs. 25 and 26. The slide-valve is a single one of substantially the same shape as is used in stationary engines. The link is suspended at the stud D (Fig. 24) by the suspension-rod, or "hanger," GD, and can be lowered or raised by means of the "suspension lever" FG, which is connected, as the drawing shows, to the reversing-lever U, the latter moving

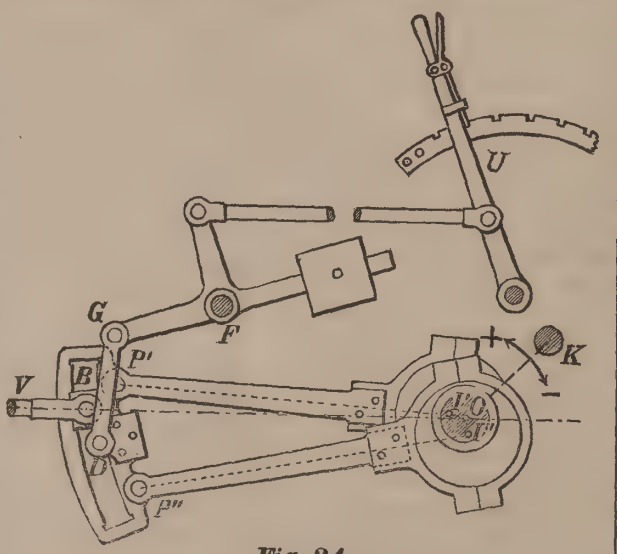

Fig. 24.

on a notched arc on which it can be fixed at any desired position. The hanger GD may be attached to the lower end of the link (see D in Fig. 25 or P'' in Fig. 26) or, to a stud secured to the centre of the link by a bridge or bracket (Fig. 24.) Sometimes the suspension lever FG is located below the link, placing the hanger in an inverted position.

The eccentric I' is called the forward eccentric, and is fastened to the crank-shaft in such a position that its operation upon the link-block B would produce a forward-rotation of

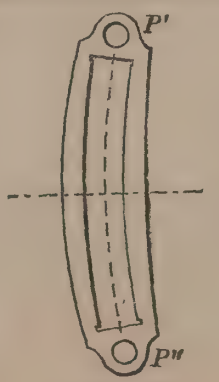

Fig. 25.

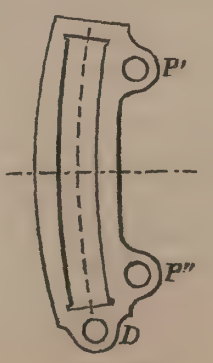

Fig. 26.

the engine. The other eccentric, I'', is the backward or backing eccentric, and would cause an opposite rotation of the engine if conected with the link-block.

When the crank-shaft rotates, these two eccentrics will transmit to the link a movement of a very peculiar character, being both oscillating and reciprocating at the same time. By lowering or raising the link either of the two eccentrics can be brought in action, and thus the engine may be run forward or backward at pleasure. The link can, however, also be used in intermediate positions or "grades" when both eccentrics more or less influence the movements of the valve, and it will be the chief object of our future investigation to find the law of the movement of the valve for any grade of the gear.

The eccentric-rods may be used either "open" or, "crossed." They are called "open" when they are connected with the link as represented in Fig. 27, and "crossed" when they are arranged as Fig. 28 shows. To make this distinction both eccentrics must be inclined *towards the link*,

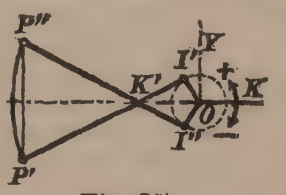

Fig. 27.

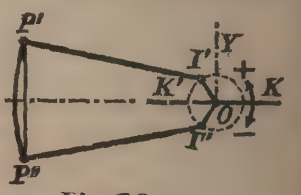

Fig. 28.

for when the crank-shaft is turned half a revolution, to bring the eccentrics on the other side, the link-motion with open rods will appear crossed, and *vice versa*, and care must be taken, therefore, not to confound both types.

When the link-block is not attached directly to the valve-stem, but to a rocker, by which the direction of motion is reversed and so transmitted to the valve, the position of the crank in relation to the eccentrics is indicated by the lines OK' (Fig. 27 and 28) as will be understood by consulting the rules given in the chapter on "the angle of advance."

A right line drawn from the centre O of the crank-shaft through the block B shall be termed the "centre-line" of the link motion. When the crank is on one of its centres, the centre lines of the eccentrics I' and I'' may form equal or unequal angles with the line OY, which is drawn perpendicularly to OB. The reason why these angles are sometimes made unequal will be given later.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

[☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*]

ENGINEERING—CIVIL, MECHANICAL &c.

The New Iron Bridge on the Lake Shore and Michigan Southern Railway, at Ashtabula, Ohio, which the Keystone Bridge Company, of this city, has the contract for building, is to be of the Pratt truss design, and will cost $19,000, not counting the expense of adjusting the parts over the chasm. It is stipulated that the structure shall be in place by September 5th.—*Railway World*, iii, 823.

The Channel Tunnel.—At a recent meeting of the French Society of Civil Engineers the proposed submarine tunnel between England and France was discussed. It appears that, owing to the geological formation of the bed of the channel and other reasons, it may be expedient to trace the tunnel, not in a straight line, but in a curved direction. M. Larousse, a hydrographical engineer, who had been invited to attend the sitting, grave the results of some calculations which he had made to determine the amount of deviation which would be likely to take place in driving galleries starting from opposite shores so that their axis should exactly meet midway between the two shafts from which they depart. Allowing the maximum error which is at all likely to be made, either in measuring distances or in reading off angles, M. Larousse calculates that in the case of a straight tunnel the total deviation of the axis would not exceed 1.28 metres from the right line joining the two starting points. With an indirect trace formed by straight lines starting from either end, and joined in the center by an arc 2500 metres in length, having a radius of 2700 metres, the maximum deviation of the axis of the two galleries would not exceed 4.4 metres. With an indirect trace formed of five curves the maximum deviation would not be more than 8.35 metres, and therefore very slightly in excess of the width of the tunnel, which it is proposed should be 8 metres.—(*Iron Age, Aug.* 23, 77.)

Bridging the Bosphorus.—CAPTAIN EADS HAS ANOTHER GRAND SCHEME, RIVALING THAT OF LESSEPS.—Captain James B. Eads, the well-known engineer of the iron bridge at St. Louis, who has long been connected with the jetties at the delta of the Mississippi river, has recently prepared plans for bridging the Bosphorus, thus connecting Pera with the Asiatic shore. Captain Eads was assisted in his calculations and surveys by A. O. Lambert, a civil engineer. The bridge will be 6,000 feet long and 100 feet wide. It will have fifteen spans, and will be almost entirely built of iron. The height of the roadway above the surface of the water will be 120 feet, 60 feet less than the elevation of the Brooklyn bridge. The centre arch will be a span of 750 feet, one of the longest spans ever contemplated. The central piers or main portion of the structure will be 50 feet thick, built of solid granite blocks fastened together with iron braces. The main piers are to be 270 feet high from foundation to summit. The cost of the entire structure is estimated at between $18,000,000 and $25,000,000, and six years is given as the time to complete it. Excellent granite is near at hand, and as the iron work will probably be prepared in France and Belgium, there will be no delay. It is also thought that cheap labor can be employed. The increase in the value of property that will necessarily follow the completion of the work, it is believed, will amply repay the cost of the project. The construction of the bridge will doubtless do much towards the completion of the Euphrates Valley Railroad, making it the preferred route to India.—*N. Y. Tribune.*

In Treating of General Principles of House Draining, Mr. T. M. Reade, C. E., remarks that in the selection of materials for drain there is a choice. The use of glazed fireclay or earthenware pipes is almost universal. The architect should insist upon a strong, well-turned material, accuracy in form, true sockets and a good smooth glaze. Pipes having a rough interior should not be used. The true laying of a pipe is of more importance than its quality. Levels must be accurately taken and sections made cannot be too strongly insisted upon; this trouble will be amply repaid in the quality of the work. A fall of 1 inch in 48, or ½ inch to a piece, is a very good one for a main drain.

An Eight-Horse Traction Engine, Boxe's patent, was exhibited recently in England, which is very simple and strong, and seems to answer its purpose well. It was driven 65 miles to the show at 4 miles an hour, and mounted a steep hill near the town in which the exhibition was held, which it is said to be able to do with a load of from 8 to 12 tons. The engine weighs 10¼ tons. Steering is effected by working the fore-axle. The engine is about 6½ feet over all and can readily pass through farm gates.—*Engineering*, cxix, 391.

Inland Sea in Algeria.—MM. Dumas and Daubree have urged several objections to the proposed artificial inland sea in Algeria, and agree with M. Naudin, who read a paper on the subject at a recent meeting of the Academy of Sciences, that its sanitary effects would be deplorable. It is thought that to fill the shallow basins of the region which it is proposed to convert into a sea with salt water would be equivalent to reproducing in Algeria all the worst features of marshy plains. Captain Roudaire, who proposed the scheme, admits that even in the centre there would nowhere be more than about 80 feet of water, and the whole coast line would have so little water that it would be little better than a sandbank with an admixture of salt and fresh water, upon which the strong tropical heat would act in the most deleterious manner for two-thirds of the year, causing a rapid decomposition of organic matter, and spreading contagion for miles in every direction. M. Naudin considers that there is no similarity between this district and Egypt, the climate of which country has been much improved by the creation of the Suez Canal and the plantation of trees; for, according to him, while Egypt lies between two seas, and is traversed by an immense river which has periodical overflows, the Algerian district is far from the sea, and is bounded by arid deserts.—*The Engineer.*

A New Ventilating Apparatus was exhibited at the recent show of the Royal Agriculture Society, invented by Mr. C. S. Hall for a special purpose, by passing noxious gases, vapors, and fumes to the chimney, or furnace, or condenser for decomposition. A Baker blower is placed on the roof, a jet of air is forced through into a large tube which connects with the chamber below, and by induction takes up and carries to the condenser without passing through the blower.

An Improved Foot-Bellows are proposed take the place of the old fashioned hand-bellows. They are set end to end on a platform and connected with a strap, so that when one is in a state of collapse the other is full, thus keeping up a continuous current at all times.

Novel Method of Deep Sea Sounding.—At a meeting of the Royal Society Dr. Siemens exhibited the instrument he has devised to ascertain the depth of the sea by a new means without using a sounding line. He has worked out the requirements, starting with the proposition that the total gravitation of the earth as measured on its normal surface is composed of the separate attractions of all its parts, and that the attractive influence of each equal volume varies directly as its density and inversely as the square of its distance from the point of measurement. The density of sea water being about 1.026 and that of the solid constituents composing the crust of the earth about 2.763 (this being the mean density of mountain limestone, granite basalt, slate and sandstone), it follows that an intervening depth of sea water must exercise a sensible influence upon total gravitation if measured on the surface of the sea. Dr. Siemens showed how this influence can be proved mathematically in considering, in the first place, the attractive value of any thin slice of substance in a plane perpendicular to the earth's radius, supposing that the earth is regarded as a perfect sphere, of uniform density, and not affected by centrifugal force.

It was in 1859 that Dr. Siemens first attempted to construct an instrument based on these principles. The difficulties he then encountered he has since overcome, and the present instrument is the result of his latest work. He proposes to call it a bathometer, and it consists essentially of a vertical column of mercury contained in a steel tube having cup-like extensions at both extremities, so as to increase the terminal area of the mercury. The lower cup is closed by means of a corrugated diaphragm of thin steel plate, and the weight of the column of mercury is balanced in the centre of the diaphragm by the elastic force derived from two carefully-tempered spiral steel springs of the same length as the column of mercury. One of the peculiarities of this mechanical arrangement is that it is parathermal, the diminishing elastic force of the springs with rise of temperature being compensated by a similar decrease of potential of the mercury column, which decrease depends upon the proportions given to the areas of the steel tube and its cup-like extensions. The instrument is suspended a short distance above its centre of gravity in a universal joint, in order to cause it to retain its vertical position, notwithstanding the motion of the vessel; the vertical oscillations of the mercury are almost entirely prevented by a local contraction of the mercury column to a very small orifice. The reading of the instrument is effected by means of electrical contact, which is established between the end of a micrometer-screw and the centre of the elastic diaphragm. The pitch of the screw and the divisions upon the rim are so proportioned that each division represents the diminution of gravity due to one fathom of depth. Variations in atmospheric pressure have no effect on the reading of the instrument, but corrections have to be made for latitude. The instrument has been actually tested in voyages across the Atlantic in the *Faraday*, and the comparisons with Sir W. Thompson's steel wire sounding apparatus showed it was very reliable.

The paper concluded with pointing out many ways in which the instrument might be of use; among others was that of indicating approaching danger if contour lines were first efficiently mapped.—*Van Nostrand's Mag.*, xvii, 288.

Fishing for Russian Torpedoes.—A letter from Erzeroum in the Hamburg *Correspondent* gives some particulars of the new corps of divers which has been organized by the Turkish government for the purpose of removing the torpedoes laid down by the Russians in the Danube and on the shores of the Black Sea. These divers, says the correspondent, are Mohammedans from Lazistan, and a certain number of them are attached to each of the Turkish squadrons cruising in the Black Sea. When the ships arrive near a spot where the existence of torpedoes is suspected, two of the divers row to the place in a very light boat, drawing so little water that there is scarcely any danger of its striking against the torpedoes. On arriving at their destination one of the rowers dives into the sea; if he finds a wire or rope by which the torpedo is attached he cuts it with a sharp instrument and returns quickly into the boat. The liberated torpedo floats to the surface of the water, the men pass a short lasso around it, take it in tow, and then row back to the ship as quickly as possible. For each torpedo thus captured the divers are paid $45, and also a sum of money equal to one-half of its value. Although the men have been often employed on this dangerous service, not a single accident has yet occurred to any of them.

—The new coal branch of the Northern Pacific Railroad is under contract. It will be thirty-one miles in length, and will extend from Puget Sound eastward to the new coal region examined and reported on last year by our townsman, Walter S. Sheafer. He found there a good cretaceous coal, but nothing to compare with our anthracite for steam purposes. —*Pottsville Journal.*

—A pure telluride of gold has been found in Transylvania; it has been called *Bunsenite*, in honor of Prof. Bunsen.

MINING, METALLURGY AND MINERALOGY.

The Establishment of Steel Works in Tennessee.—The Roane Iron Company, of Chattanooga, have definitely decided to build at once steel works in connection with their other extensive plant at that place.—*Eng. & Mining Jour.*, xxiv, 172.

Valuable Mineralogical Discoveries in Canada.—Prof. Vennor, Geological Surveyor, who is exploring the regions of White Fish, Pemchange, and St. Mary's Lakes, on the Upper Gatinian, reports the discovery of an immense mountain of pure crystaline phosphate of lime, showing on the surface hundreds of thousands of tons which will yield 90 per cent. He thinks it is the junction of two great belts running up the Lievre and Gatinian rivers. He believes the Lake Superior silver-bearing rock runs across the head waters of the Gatinian Rivers. He reports, also, the discovery of a reef.—*Eng. & Mining Jour.*, xxiv, 172.

Wonderfully Rich Gold Mine in New Zealand.—The mail delivered during the week brings intelligence of one of the greatest discoveries yet made in the province. The discovery is at the Moanatairi Mine, in the Thames gold field, not a great distance from the celebrated "Caledonia" Mine, which in two years returned half a million sterling from a depth of 50 fms. The Moanatairi Mine was productive to a depth of about 200 feet, when the lode became very poor. The company, nevertheless, decided to carry on operations, although at a great loss; and, after working for over two years, struck the lode again nearly 100 feet deeper, when it was found to be from 8 feet to 10 feet wide, and almost solid gold. The returns since have been enormous—for the fortnight ending March 3,709 ozs.; March 17, 4,913 ozs.; March 31, 16,662 ozs. Making a total of 22,284 ozs., of the value of 70.000*l.* The yield for the last week of the above return was 10,298 ozs., and the profit for the fortnight reached the amazing sum of 83,000*l.* The fortunate shareholders have received

in a little over a fortnight over 60,000*l.*, being 4*l.* 10*s.* per share. The last report says: "The present aspect of the mine warrants the prediction that the returns from the present level will continue splendid, to say nothing of the block underfoot, which according to all precedent should not only equal but exceed the block now worked. The height of the present block is 80 ft., by any number of feet in a southwesterly direction. This is another instance of the success attending persevering efforts in mining, and should act as an encouragement to shareholders in other concerns, and warn them against the folly of letting their property be sacrificed when a sustained and united effort would, in the majority of instances, effect a great success.—*London Mining Journal.*

Bicheroux Gas Furnaces.—All the heating and puddling furnaces at the Ougrée Works, Belgium, are now worked by gas on Bicheroux's system. Formerly there were 27 ordinary single puddling furnaces, which have been supplanted by 15 gas furnaces, each with two working doors. The 27 ordinary furnaces required 108 men for day and night service, 54 being master puddlers. The 15 gas furnaces now only require 90 men, of whom 30 are master puddlers. The work at the gas furnaces is much lighter than at ordinary furnaces. The saving of coal at Ougrée, since the general adoption of the gas furnaces, amounts to 30 tons per day, and the coal used now is of an inferior kind, therefore cheaper. There is a plentiful supply of steam, though there are fewer puddling furnaces. No other boilers are used than those attached to the heating and puddling furnaces.—*Iron* x, 199.

Bessemer Steel Production.—Some interesting facts in connection with the Bessemer steel trade have just been published by the *Moniteur des Interets Materiels* of Brussels. From the statements made by this journal it appears that in the province of Liege the production of Bessemer steel during 1875 was 47,200 tons, of the value of 14,124,000f., whereas the value of the 72,500 tons produced in 1876 was only 15,570,000f. From these figures it is deduced that the average prices at the works were 427f. per ton in 1874, 299f. in 1875, and only 215f. in 1876, the value having thus fallen 50 per cent. within a period of two years. The whole production of iron and steel in the entire world in 1873 was 10,450,000 tons, of which Europe was credited with 8,600,000 tons. In 1875 Europe only produced 7,900,000 tons, including 1,400,000 tons—or 17.70 per cent.—of steel. The total consumption of Europe in the same period was 6,700,000 tons, so that the inference is drawn that the production exceeded the demand in 1875 by 1,200,000 tons, the cause being "no other than the introduction of Bessemer steel." The manufacture of this steel began to develop in 1870, and has since been so rapid that there are now no fewer than ninety-four Bessemer steel works, employing 317 converters, in existence. Estimating the production of each of these converters at 10,000 tons annually, which is said to be about the average of Belgium, but probably below that of the United States, the existing Bessemer steel works would be able to supply a demand for 3,170,009 tons annually, or fully 50 per cent. in excess of the demand. Thus far we have been quoting from the journal named above, but we must say that, although some of the statistics are put forward with somewhat startling clearness, we must demur to the inference that because Europe produced more than was used on that continent, the balance must necessarily be surplusage. We known very well that such is not the case, for the simple reason that the greatest iron and steel producer of the world—England—is in Europe, and she sends a very large proportion of her iron and steel manufactures to every part of the globe, which is thus probably accountable for the surplus which so greatly troubles our Belgian contemporary.—*The Engineer.*

Petroleum Statistics.—"Stowell's Reporter" gives the following statistics of this industry, at the end of July of this year:

Stock on hand at the wells	109,224	bbls.
Production for the month	1,189,005	"
Daily production	38,355	"
Number of producing wells	7,567	
Number of dwilling wells	365	
Stock in iron tanks, pipe line and refineries	2,895,504	"
Total stock on bond, Aug. 1, 1877	3,004,728	"
Total shipments for the month	1,096,951	"

—The following shows the total shipments of iron ore from the Lake Superior district for the season, together with those of a corresponding period last year:

From where	1876.	1877.
From Marquette	246,703	396,306
From Escanaba	188,620	220,487
From L'Anse	42,319	44,273
Total	471,642	571,962

Showing an increase of 99,420 gross tons.—*Marquette Mining Journal.*

The Nair Furnace is attracting considerable attention; the furnace converts the coal or slack (which last is preferred) into gas, which combined with a current of hot air, (about eight hundred degrees) produces thorough combustion before it comes in contact with the metal. This produces the same result in the quality of the product as the natural gas now used in some of our mills. A great economy of fuel is also secured, which amounts to a saving of fifty per cent. if the run of the mine is used, or more if slack, as twenty bushels of slack is ample for the production of a ton of puddled iron. Another important feature is that the percentage of loss from the pig iron to the puddled iron is less, as is case with natural gas. As the furnaces cost but little more than the ordinary style, and as the old furnaces can be changed at a small cost, our manufacturers need not be long in giving them a trial. As these furnaces are much less expensive in the matter of repairs, owing to the fuel being much less destructive on brick, they will play an important part in helping to meet the new basis of prices to which the trade has been driven.—*Cleveland Trade Review.*

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Influence of Light on Electrical Conductivity of Certain Substances.—The experiments made by Dr. Börnstein show that the electrical conductivity of the metalloids selenium and tellurium increases if exposed to the action of luminous rays, which is the same effect in the case of platinum, gold, and silver, and it is thought probable that sensitiveness to light is a general property of all metals. Two methods of measuring the resistance were used to avoid mistake. He summarizes as follows: 1st. The property of experiencing a diminished electrical resistance under the influence of luminous rays is not confined to the metalloids selenium and tellurium, but belongs also to platinum, gold and silver, and in all probability to metals in general. 2d. The electrical current diminishes both the conductivity and the sensitiveness to light of its conductor, but both of these, after cessation of the current, gradually acquire their former values.—*Phil. Mag. Sup.*, June.

Mars' Satellites.—Prof. Newcomb, of Washington, in a letter to the *New York Tribune*, gives the reasons why these satellites were not observed previously. Mars is now nearer than at any time since 1845, when the great telescopes were little known. In 1865 they were not sought for, and in 1875, too far south of the equator. The next opposition will occur in 1879: then for 10 years they will probably be invisible, owing to the great eccentricity of the orbit of Mars. In 1892 a favorable opposition will again occur. During the present year it is hardly likely that these satellites will be visible after October. The shortest period of revolution heretofore known is that of the inner satellite of Saturn, 22½ hours, the inner one of Mars is 7 hours and 38 minutes at the distance of 4,000 miles from its (Mars') surface, which is about $\frac{1}{60}$ of the distance of the moon from the earth; it is also about $\frac{1}{4}$ of the revolution of the anterior satellite of Mars. These satellites are the smallest heavenly bodies yet known. They appear through the telescope only as faint points of light, so it is barely possible to estimate their diameters. The Professor says, these objects must be regarded as among the most remarkable of the solar system. Not the least service which Professor Hall's discovery will render to astronomy is that of the exact determination of the mass of Mars and a subsequent simplification of the theories of the four inner planets.

The Personal Equation.—By this and similar cases the attention of scientific men was called to the effect of personal characteristics in classes of work similar to that of the astronomical observatory. Examination showed that these characteristics are a constant cause of error. By numerous experiments it appeared that one who observes and records an occurrence always gives a result which differs from the exact truth. Even where the observer was trained and skilled in observing events like those in the experiment, the rule was the same. He recorded the time too early or too late. The error would appear in each experiment, and always to the same amount. If the record was too late in one, it invariably was too late. This habitual difference between the time as noted by an observer and the actual time of the happening of the occurrence is what has been termed the absolute personal equation of that observer. It represents the amount of error which he will always make. It has been found to differ with the different persons for the same class of events. It also differs in the same person for events of different classes. The time required to observe and record the happening of a sudden and unexpected spark, for instance, is always greater than that required in the case of the expected appearance of a letter or figure thrown upon a screen. The equation also differs according as the facts are observed by the use of one of the senses or of another. The time required for some of the senses to convey intelligence to us is far greater than that required by others.—T. F. BROWNELL, *in Popular Science Monthly for September.*

Lakes Tahoe and Echo.—At a recent meeting of the California Academy of Sciences, Dr. James Blake read a paper on the temperature and organic remains in Tahoe and Echo lakes. By an accident while descending the mountains he lost his note-book, but he related from memory the prinprincipal facts observed. In the examination he used, among other things, a Casella deep-sea thermometer. In the middle of July he found the surface water of Lake Tahoe at the temperature of 62°, when the temperature of the air was ranging from 36° to 76°. Near the south shore the temperature of the water would rise during the hottest part of the day, but would return to 62° at sunrise though the air was 36°. This high temperature was found in the shallower water, when the depth for half a mile from shore gradually increased to 160 feet. Beyond this the depth suddenly increased so that the next sounding gave 560 feet, with a bottom temperature of 39.7°, the temperature at the surface remaining at 62°. Lake Echo is 1,000 feet above Lake Tahoe and about 150 feet deep; the temperature at the bottom at a depth of 145 feet was 41.3°. There was snow in spots near the shores of the lake. The surface temperature was from 56° to 62°, the surface of the air varying from 30° to 70°.

He found the surface of the water swarming with cirripeds; near the surface he found the perfect insect, at 20 feet he found the ova in different phases of development, but not a perfect insect. At the bottom of Lake Tahoe, at the depth of 560 feet, he found the same deposit of disintegrated granite which is found on the shores of the lake. It seems evident, says Dr. Blake, that the basins of Echo lake was ground out by ice action, and Lake Tahoe having been the receptacle of the washings from the mountains, but that the glaciers had little to do in modifying it. He does not agree with Prof. Le Conte in considering that the smaller lake was formed by ice action, but that while the shores were formed by moraines they are deep mountain fissures modified by ice action.

The Prize Method of Determining Phosphorus. *To the Secretary of The American Iron and Steel Association.*—SIR:—Your favor of the 25th ult., asking for a description of Korschelt's method of determining phosphorus in ores, etc., has been received. The Society for the Advancement of Industry in Berlin offered a prize of 1,500 marks for a quick method of giving accurate determinations of phosphorus in ores, iron, and steel, and awarded it to Mr. O. Korschelt, professor of chemistry in Yeddo, Japan. His method was thoroughly tested by Prof. Rammelsberg, who stated that the method, although not new in principle, is an improvement. It gives perfectly accurate results, and is perferable to all other proposed methods. A detailed description of the method and upon what it is based is given by Korschelt in the April number of the *Verh. des Vereins zur Beförderung des Gewerbefleisses.* Prof Rammelsberg's detailed report is appended. The publication can be obtained form the Nicolai'che Buchhandlung, Berlin.

The following is a short description of the manipulation: Iron or iron ore in the possible finest form is gradually added to as little concentrated nitric acid as possible, which is kept boiling. About as much iron is taken as will make the yellow precipitate weigh 0.5 to 0.75 gr. One gram is necessary when the iron contains one per cent. of phosphorus. Then the solution is filtered into a solution of molybdic acid which is heated in a water bath, or filtered into a dish which stands in the water bath, and the solution of molybdic acid added, which was also heated in the water bath. One should never let the solution of iron amount to over 50 c.c. and should wash with water containing nitric acid. If the percentage of phosphorus is approximately known in the iron to be analyzed, then one will know about how much solution of molybdic acid will be required; if the percentage of phosphorus is unknown then take 30 c.c. These precipitate the phosphorus completely out of a solution of one gram of iron containing one and three-fourths per cent. of phosphorus. Then test whether it is necessary to add more molybdic acid, by pouring out a small quantity of the solution. The yellow precipitate which covers the solution as a film is held back with a glass, or the dish is held obliquely, whereby the film draws to one side, and then some of the solution is taken with pipette. After a complete precipitation, heat for a short time, filter through the weighed filter, wash with water containing nitric acid (two to three per cent.) and alcohol, and then place into a drying apparatus, which is heated to 120 or 130°. In twenty minutes the filter is dry and is then weighed. If washed well with alcohol the precipitate has kept its yellow color. The weight of the precipitate is multiplied by 0.0173, as its contents in phosphorus amount to 1.73 per cent. and then the percentage is calculated.

When the *solution* does not make special difficulties, Korschelt states that his method takes from four to five hours; whereas others take from one to two days. Please refer those who wish a detailed description to the above-mentioned publication. Very respectfully, GEO. W. GOETZ.

Berlin, July 17, 1877. —*Bulletin*, xi, 226.

Bamboo as a Source of Paper Stock.—The steadily increasing demand for fibre for paper-making has driven our manufacturers to the ends of the earth in search of new fibres. Not a few have looked with longing eyes upon the wealth of raw material going to waste the world over, in bamboo thickets; and many attempts have been made to convert such fibre economically into paper stock.

Mr. Thomas Routledge, a progressive paper maker, claims that the slow progress made with this plant has been due not to any inherent unfitness of the bamboo, but to the fact that insufficient attention has been paid to age of material used.

Like the asparagus plant, the bamboo is succulent and tender when young, but rapidly becomes hard and woody with age. When mature, it is, as all know, exceedingly dense, and in most varieties the outer part is so hard and silicious that it will strike fire like flint. To convert stems at this stage into pulp, they must be subjected to long-continued boiling in strong solutions of caustic alkali, at high temperature, under a pressure of ten or eleven atmospheres; a process at once difficult, costly and dangerous.

Mr. Routledge finds that these objections may be obviated, and the bamboo made to furnish excellent fibre cheaply, simply by using the plant when young and green. Before the stems become indurated and woody, a very mild treatment of alkaline baths, at atmospheric pressure, suffices to dissolve the mucilaginous and extractive compounds combined with the tissues, so that the fibres may be readily separated pure and free.

For many years Mr. Routledge has devoted much time to the investigation of new fibres for paper-making, testing both chemically and practically as a paper-maker nearly every known fibrous material; and he does not hesitate to say that no other fibre can approach the bamboo in economy of production, and very few, if any, in the quality of the stock it yields for the manufacture of paper. And it has the further advantage of being practically inexhaustible in quantity. The bamboo is of extremely rapid growth, and it flourishes in every tropical country. Grown under favorable conditions of climate and soil, it excels every other plant in amount of available fibre to the acre, and there is no plant which requires so little care for its cultivation and continuous production. The estimated yield is twenty times that of flax, hemp, jute or cotton.

In view of the threatened exhaustion of the supply of esparto, owing to the greed of the native collectors, the utilization of the bamboo promises to be a great public advantage, even if the paper produced from it falls far short of Mr. Routledge's anticipations. The sample furnished—Mr. Routledge's pamphlet on "The Bamboo Considered as a Paper-making Material" being printed on bamboo paper—shows it to be fully equal, indeed superior, to most of the common and cheap news paper in use. In fineness and strength it surpasses any made use of by our great dailies, and in color all but the *Herald*. It has, however, the serious fault of semi-transparency, the letters showing through.

As an essential point in the proposed plan of utilizing bamboo for paper-making consists in the use of young and preferably freshly-cut stems, it will be necessary to have the fibre prepared where the bamboo grows, thus adding a new industry to tropical regions.—*Drug Circular*, xxi, 158.

Octahedral Crystals of Copper.—M. Sidot has allowed sticks of phosphorus to lie for some months in a cold saturated solution of sulphate of copper, and has obtained a series of copper tubes, the outer surface of which was covered with fine octahedral crystals of the metal. In this reaction the water is decomposed, metallic copper and phosphide of copper are formed, whilst sulphuric and phosphoric acids remain in the liquid.

Tinning Thin Cast Iron.—In tinning thin cast iron goods they run the risk of losing part of their substance by the filing or friction necessary for the removal of the oxide with which they are coated, or of twisting out of shape in the furnace if the oxide is removed by heat. They run the same risk from heat employed in the ordinary process of tinning. Where it is of consequence to avoid these evils, the first may be obviated by scouring with sand and a solution of 2 parts sulphuric acid in 8 of water until the rust vanishes. The goods are then washed with rain water and set in a solution of 1 part sulphate of copper in 8 parts water. Here they are left till they have become coated with a faint red coating of copper, which is cleansed with sand and water. They are now brushed with a solution of chloride of zinc and dipped at once into the melted tin. If it is desired to give brilliancy to the tinning, the goods are again dipped, the second time in a second vessel, the molten tin in which is covered with a layer of tallow. The tallow prevents the tin from oxidizing during the operation, and the goods come out bright. The coppering of the goods before tinning, facilitates the latter operation, which may be conducted at a heat such that the goods run no risk of warping.—*Iron* x, 195.

Sebastine.—This blasting material, which is more effective and less dangerous to handle than any other, explodes only by a forcible blow, and is only ignited by a powerful cartridge or gunpowder. When frozen it must be melted by being placed in a reservoir of hot water. The preparation commercially marked "Ny Sebastine" is free from chlorate of potassa, and is in consequence even less dangerous, but is said to possess an explosive power even greater than the common sebastine.—*Berg. and Huett. Ztg.*, xxxvi, 275.

The Metal, Columbium, which was discovered some fifty years ago, and which resembles nickel in its properties, but is more like tin in color, is now talked of as a substitute for both of these metals, in the plating process. It has been very scarce, but deposits of it have recently been discovered in North Carolina and Colorado.

The Internal Friction of Black Hard Pitch is shown to be subject to the same laws as fluid friction, by experiments of M. V. Obermayer, of Vienna. The internal friction of soft bodies do not appear to follow the same laws as fluid friction.—*Nature.*

The Penetration of Flow of Air and gases through walls of building and even of stone, with wonderful facility has been shown by experiments by Professors Märker and Schultze.

MISCELLANEOUS.

The Process of Cremation suggests a means to solve the serious question, what shall be done with the street refuse and garbage. An analysis of collections from 13 representative districts give the following average results:

Water,	3.032 per cent.
Nitrogen	0.369 "
Combustible material	28.454 "
Incombustible material	68.514 "

Prof. Chandler, President of the Board of Health, suggests that a system of garbage cremation in furnaces similar to those in the manufacture of shell-lime. It is said that 200 tons of refuse and garbage can be cremated and rendered innocuous in 24 hours. Such a system would involve less cost than conveying it to deep-water, and be far more consistent with the demands of civilization and public safety.—*Am. Architect.*

The Sewing-Machine.—The sewing-machine first appeared as a practical invention about thirty years ago. Thimonnier, the real originator of the idea, was a Frenchman, and, like too many great inventors, he did not live to enjoy any part of the fruits of his genius. Elias Howe, who followed Thimonnier, was an American working artisan, and found his first real support in England about 1847. At the present time, that is, about thirty years after the establishment of the invention, there are upwards of 4,000,000 sewing-machines in use in various parts of the world; and the annual number of new machines produced in this country is estimated at 80,000, employing about 100,000 persons. In France, Germany, and Belgium, the production of machines is very large, and in the United States the annual number turned out is perhaps greater than in the whole of Europe. In 1862 it was estimated that in the United States each machine saved to its owner $10.50 a week, or say $650 per annum, in wages alone, or an aggregate saving in wages, for the whole country, of about $50,000,000. In 1875 the aggregate saving had risen to $500,000,000.

As the general result, Mr. Plummer says that "taking all various industries in which the machine is used, the wages of the machinists may be estimated as being from 50 to 100 per cent. *higher* than the wagers received by hand-workers before the machines appeared in several industries." And he goes on to add: "The changes introduced by the machine have been with considerable advantages as regards the physical and social condition of the workers. There is a great improvement in their health and in the comfort of their homes. As regards the shoemaking population, both male and female, the change amounts to an absolute revolution, and decidedly for the better."

The sewing-machine has most effectually stimulated invention in other directions. In all leather manufactures, for example, the old, painful, unhealthy processes are now nearly all done by machinery driven by steam. In the stay and clothing trades the severe labor of using heavy shears by hand is superseded by steam-driven cutters, by the aid of which one man does the work of twenty. The cheapness arising from these appliances has so enlarged the demand that the quantity of labor employed in these trades is far greater than before.—*Popular Science Monthly.*

—The Pennsylvania Railroad Stock-yards and Abattoir of Philadelphia is the subject of an extended article in the *Engineering*. They occupy an area of 21 acres, and every provision has been made to ensure cleanliness and render the the renewal of any portion of the structure easy, and considerable attention has been paid to ventilation.

American Stamping Machinery for Australia.—During the past year or two the canning business has become an important industry in Australia, and large quantities of both fruit and meats are put up in this way annually. To meet the demand an important business in the manufacture of cans has sprung up, and we are gratified to learn that the Ferracute Machine Company has lately shipped a large number of power presses and dies to a tinware manufacturer in South Australia.

Our Foreign Trade.—The returns of the foreign trade for the past fiscal year ending June 30, show that the value of imports bear to that of exports the proportion of 3 to 4.

A Cure for Rattlesnake Bite is graphically described in the *Med. & Surg. Reporter* by D. J. J. Knott, of Atlanta, who cured in three days a man who had been bitten on the index finger by a large sized rattlesnake.

The Municipal Debt of the United States is the theme of a writer whose figures are worthy of confidence, who produces a table showing the debt, valuation, taxation and population of 130 cities of the United States for the years 1866 and 1876 respectively. The cities selected are of the representative class, and show for 10 years:

An increase of debt amounting to about	200	per cent.	
An increase of annual taxation....	" 33	"	
An increase of valuation.....	" 75	"	
An increase of population.....	of 33	"	

—The Wrought Iron Bridge Co., of Canton, N. Y., has the contract for rebuilding the bridge over the Connecticut River, at Northampton, Mass. The bridge has a total length of 1,219 feet, in eight spans, with 18 feet roadway, and will cost about $27,000, exclusive of flooring. This company is also building a 930-foot bridge in six spans, with 16 feet roadway, at Columbus Junction, Iowa, being the longest highway bridge in the State, and has the contract for six 120-foot spans, with 18 feet roadway and 5 feet sidewalk, at Paris, Ont. They have just completed a 160-foot bridge with 30 feet roadway, and two 8 feet walks on iron piers, 25 feet high at San Jose, Cal., and are building a 256-foot span, with 18 feet roadway, at Preston, W. Va. All of these above bridges are on the company's patented truss plans, with all wrought iron details. The company has now over 12,000 feet of bridging in process of construction.

—The Harlan & Hollingsworth Co. report car building at present very slack, although they have had a very fair trade until recently. Their last contract was for about 20 first class passenger cars for the Dom Pedro Railway of Brazil. In their shipbuilding department the company has under way one large iron steamer for the Morgan line of New York, and are also deepening the Morgan City, which was built for the same firm about a year ago. They are also building a large boat for one of the Brooklyn ferries and one for Philadelphia and Camden.

—Henry Disston & Son's Keystone Saw Works, Philadelphia, are employing a full force fifty hours per week in the saw department. In the steel mill and file department they are exceedingly busy, having orders ahead for their full capacity for over a month, and there is every prospect for its continuance.

—The Baldwin Locomotive Works, Philadelphia, have a force of 1100 men employed ten hours per day. Several new contracts for locomotives have been received recently, among which are the following: Ten engines for the Missouri, Kansas and Texas Railroad, four for the Atlanta and Charlotte Air Line, and five narrow-gauge engines for the South Pacific coast.

—The Jarvis smoke-consuming furnace seems to be growing rapidly in favor among steam-users. The following boilers have been recently reset in this way: Mutual Life Insurance Company of New York, in their new building, corner of Tenth and Chestnut streets, Philadelphia, have two in operation; Louis Oliver and Phillips, Pittsburg, have six; Columbia Conduit Company, Pittsburg, one. There are now being reset for Mr. Markle, of Pittsburg, three; Black Diamond Steel Works, six.

—The Tiffany Refrigerator Car Company, of New York city, is shipping large quantities of dressed beef from Kansas City to St. Louis, and also to Chicago.

—The Aquarium Company of Manchester, England, have been obliged to announce that they must sell their fine collection of aquatic animals and plants. The aquarium has not been so successful financially as it has from a scientific point of view.

—The tomb at Sparta, near the Hymettus, where Mr. Stamatsky has been conducting an exploration under the direction of the Archæological Society of Athens, has yielded relics of an ancient civilization very similar to those discovered by Schliemann at Mycenæ. A collection of about 1,000 articles of archæological value has been secured, chief among which are small tablets of ivory inscribed with characters bearing a close resemblance to the ancient Assyrian.

—The Signal Service Bureau reports of the are weather consulted by the riflemen at Creedmoor.

—An immense fire-proof elevator is to be constructed at the terminus of the Erie Railway in New Jersey, on the pier formerly occupied by the White Star Steamship Company. The building will cost $600,000, and have a storage capacity of 1,500,000 bushels.

—The Cambria Iron Company is shipping several hundred tons of steel rails by Gray's Iron Line to Louisville, for the Louisville and Nashville Railroad.

—The Californians are quite proud of the steamer lately built for the Sandwich Islands government. It is 127 feet long and 592 tons burden, and is the largest steamer yet built in the private ship yards of California. There was much rivalry between England and California for the order to build the vessel, but the latter finally secured it through the good influence of the reciprocity treaty between the United States and the Sandwich Islands. It is hoped that further orders for vessels will follow from the Pacific islands.—*Railway World*, iii, 825.

—The Fairbanks have executed orders from the United States government the past three years for over 7500 scales. This firm is still furnishing—under contract with the various departments—scales for all parts of the country. In a contract just secured from the Treasury Department for the fiscal year (which expires June 30, 1878) the government shows its preference for Fairbanks scales by paying the St. Johnsbury firm 33⅓ per cent. more than the bid of competing parties.—*Springfield (Mass.) Republican.*

—Sir Jos. D. Hooker, the distinguished botanist, is with the Hayden Exploring party in their Rocky Mountain excursion. He says that the flora of this country is more varied and instructive than any other in the Temperate Zone.

—Prof. J. C. Watson, of Ann Arbor, has discovered another planet.

—Mr. Hotchkiss, an inventor, whose improved revolving cannon we illustrated some time since, has received intimation that his system has been approved by the French Government, and that they have decided to adopt his cannon.

—The news of the discovery of a perfect mammoth in Tomsk is false. M. Polyakoff, sent immediately by the St. Petersburg Academy, writes that he found only a large piece of mammoth flesh with skin and hair.—*Nature.*

—Dr. Dutt, a Hindoo physician at Calcutta, describes a method of preparing paper for manuscripts, the object being to render the paper proof against insects and decay. The method of preparation is chiefly the use of a sizing made of arsenic tri sulphide (orpiment) and an emulsion of tamarind seeds. The efficacy of arsenic for such purposes is not to be questioned, but the dangers of its use would probably surpass its advantages.

—A type foundry in St. Paul has lately furnished the types for the *Framvavi*, an Iceland newspaper, to be published in in the Icelandic colony at Keewatin, on the Red River, in British territory, about sixty miles from Fort Garry. This will, according to the *New York World*, be the first newspaper published on the American Continent in the Icelandic language. The preparation of the types required the greatest care. They are in the Roman alphabet, but with a great many peculiarities in regard to accentuation, and are of a very antiquated form.—*Van Nostrand's Mag.*, xvii, 276.

—The Norwalk (Conn.) Lock Company started work the other day with 100 hands.

—Business at the Machine Works of S. C. Forsaith & Co., Manchester, is good.

—East Haddam, Conn., is to have a watch factory, with Emily J. Hathaway as chief owner.

—Summarizing from Poor's Manual, we find that not a single railway company in Vermont, Kansas, Nebraska, Missouri, Dakota, Colorado, South Carolina, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, California, Oregon, Nevada, or Washington Territory, paid a dividend to its stockholders last year. That is, the entire railway system of seventeen States and Territories, with an aggregate mileage of 15,111 miles, paid its stockholders nothing, and, in many cases, the bondholders fared little better. Furthermore, out of 811 companies reported in the country, only 196, or twenty-four per cent., are given as paying any dividends.—*The Railway Age.*

EDITORIAL CORRESPONDENCE.

ERRORS IN TABLES.

PHILADELPHIA, Aug. 31, 1877.

EDITORS POLYTECHNIC REVIEW :—

On page 96, current volume, Mr. John C. Trautwine refers to an error in my *Pocket-Book*, which occurred in old editions, but was corrected about five years ago. $\sqrt[3]{936} = 9.7819469$ in the late editions of my *Pocket-Book of Mechanics.*

Very respectfully, JOHN W. NYSTROM.

ANSWERS TO CORRESPONDENTS.

IRON FOR CANNON. (A. H. F., Pittsburg, Pa.) The "strongest" sorts fail from brittleness. Metal must be chosen that is hard enough not to be spongy, and soft enough not to be brittle.

COPPER "BRITTLING." (H. P. S., Columbus, O.) Copper is originally brittle. By refining and annealing, it becomes soft, malleable and ductile. A bad founder will "brittle" it by permitting it to absorb carbon.

INFUSORIAL EARTH BREAD. (J. B. T., Cleveland.) This might do very well to keep the sides of the stomach from rubbing together, but there are plenty of things that will do better than that. The article in this journal including bread making as one of the uses of infusorial earth (*berg-mehl*) mentioned that point as a matter of statistics, and of course did not recommend the material as a food. School-girls and pregnant women eat slate-pencils, but physicians never prescribe them.

THE WOOL PRODUCT. (H. A. S, Lowell.) We have no tables later than those of the 1874 production. Of the 2223½ millions of pounds, South America produced 350, Asia (excluding Turkey) 320, Australia 250, the United Kingdom 200, the United States 200, France 150, Russia in Europe 150, both the Turkeys 140 millions.

TEMPERATURE AS INFLUENCING STRENGTH OF IRON. (E. B. C., Buffalo.) Fairbain showed that No. 2 cast iron was stronger at the freezing point than elsewhere, to resist transverse strain and impact; losing 14.4 per cent. of transverse strength and 28.5 of its impact strength, by being raised from 32° to 113° F. No. 3 or hard irons, however, were stronger at high than at low temperatures.

CASHMERE SHAWLS. (E. A. F., Philadelphia.) These are made of "pashum" or shawl-wool, a downy substance found next the skin and below the thick hair of the Thibetan goat.

A DEGREE OF HARDNESS OF WATER. (F. S. W., Reading.) By one degree of hardness it meant that a gallon of water contains in solution an amount of salts which would precipitate as much soap as one grain of carbonate of lime would. Up to six (6) degrees, water is called soft; over six degrees it is called hard.

AQUEDUCTS OF ROME. (L. C. M., Pottsville.) There were nine; two first built were underground in case of invasion; one of these 11 miles long. The third was 39 miles long, and the next two were built on top of it,—showing good masonry. None of these nine employed inverted siphons to cross low planes; but those built by the Romans at Lugdundum (now Lyons, France) followed the undulations of the country.

BIBLIOGRAPHICAL NOTICES.

STEAM TOWING ON RIVERS AND CANALS BY MEANS OF A SUBMERGED CABLE. F. J. Meyer and W. Wernigh. 60 pp. 8vo, illustrated. E. & F. N. Spon, New York.

When the Legislature of New York offered a prize of $100,000 for a successful system of steam towing, that should be more economical than horse towing and would not wash the banks, it meant to do a very good thing. But when there was excluded from the competition the only system that we know of that *does not* wash the banks—a system (that by submerged wire ropes) that has been in continued and extended use in Belgium and elsewhere in Europe—the Legislature simply stultified itself and deprived the community of all opportunity to obtain cheaper canal transportation. And while the work before us is avowedly produced by the patentees of a submerged-cable system, still facts are not changed on account of this; and while recommending our Canal Commissioners and our Legislators to get and read this book, we extend the same advice to all those interested in cheap towage. The fact that recently, when traffic lightened on one of our Maryland canals, the propeller-boats had to lay up until times got better, and the horse-boats kept on their regular course, does not strike us as a very forcible argument in favor of propeller-boats, which will do well enough and do serve well enough wherever they are allowed to splash a little, but which will wash banks, as long as water remains only a fluid abutment, and wire cables are definite and tangible purchases for the engine of a canal-boat to pull upon.

SELECTED LIST OF U. S. PATENTS.

AUGUST 7, 1877.

Patents granted August 7, 1877, 228; Reissues, 11; Designs, 8; Trade Marks, 34; Labels, 12.

193,801. COCKS FOR FAUCETS FOR WASHBASINS, &C. James E. Boyle, Brooklyn, N. Y.

The valve moves as a detached piston in a cylinder, the seat being concentric with said cylinder and at its lower end. Said cylinder above said valve is closed and water from the service pipe has access thereto, so that both upper and lower faces of said valve are exposed to pressure of the water. The pressure upon upper side predominates in proportion as its upper surface is of greater extent than the lower. The valve will therefore close by its own gravity accelerated by water pressure. When it is desired to lift the valve, a small valve in the top of said cylinder is opened by pressing a button, and the water therein is permitted to escape; the pressure on the under side will then lift the main valve The valve is therefore opened and closed by means of the water pressure in the service pipe.

193,813. ARTIST'S PENCIL FOR STRIPING. O. P. Gash, Missouri City, Mo.

This device consists of a tubular handle to contain liquid paint, and a suitable wheel set in the bottom of said tube to take out and deliver said paint upon the surface over which the wheel is caused to roll.

193,816. OBJECTIVES FOR OPTICAL INSTRUMENTS. E. Gundlach, Rochester, N. Y.

This lens consists of an ordinary double or triple acromatic combination, with the addition of one or more concavo convex lenses of crown glass, of dissimilar curvature, for independently correcting spherical aberation.

193,829. CENTRE BOARD FOR VESSEL. W. W. Palmer, Jersey City, N. J.

In this invention the centre board is adjustable sideways at one end, so as to place it more or less oblique to the keel, and thereby cause it to assist in steering and trimming the vessel.

193,838. PROCESS FOR STEAMING OIL WELLS. A. J. West, Conneautville, Pa.

To clean out the paraffine and other solidified matter which obstruct the flow of oil, a jet or current of superheated steam is discharged at the bottom of the well.

193,850. STOPS FOR ENGINE LATHES. C. A. Cooley, E. Hartford, Conn.

A stop rod having been adjusted, the tool carriage strikes the arm on said rod the instant the work is done, withdraws the bolt from the notched disk, and a spring in the barrel turns the shaft about which it is coiled and the disk with its pin, and throws down the lever which carries the gears, thereby disengaging them.

193,874. JAQUARD MACHINERY. W. P. Jennings, Brooklyn, N. Y.

A cam wheel of peculiar construction, in connection with gearing and rotating arms, gives positive intermittent motion to the card cylinder. A heater is also attached in such a manner that the cards cannot be injured by the moisture in the atmosphere.

193,877. STEAM RADIATORS. J. J. Lawler, Scranton, Pa.

The upper end of each pipe is screwed into a bushing, the outside thread of which is slightly greater in pitch than the inside. The bushing is screwed into the top nearly to its seat, and the pipe is then screwed into the base, and the bushing is finally screwed home. The difference in pitch between the outer and inner threads imparts a differential effect in the final motion of the bushing, which draws all the parts tightly together.

193,884. SPINNING MULES AND JACKS. J. Martin, Reims, France.

To the frame or carriage of the mule is secured a rod carrying sets of hooked needles, which correspond in number to the threads carried by the mule. A reciprocating motion is imparted to the needle bar, so that the hooked needles thereon shall pass between the threads during the inward run of the carriage, and when said carriage has nearly completed its inward run the needles are withdrawn, thereby breaking any two threads that may become twisted or entangled.

193,885. AUTOMATIC CANAL LOCKS. Wm. L. Marshall, U. S. A.

The gates are operated entirely by the buoyant effort of the water in the canal, power being transmitted to the maneuvering shaft through an endless chain coupled with the windlass. The windlass is operated by the raising of the buoys or during their descending movements, or both. The gates are hinged below the centre of water pressure thereon, so that they will be properly crowded to their seats, and the axis is made movable to avoid too great strain. The valves are axled below their centre of pressure, so that the tendency is always towards a closed position, and a small supplementary valve easily operated, is axled within the main system above its centre of pressure. By releasing the supplementary valve it is thrown open and the centre of pressure of the whole system thus changed from a point above to one below the main axle, which causes the valves to be automatically opened. The water way, which may be a hundred or more square feet, is thus controlled through the medium of a simple valve of only two or three feet area. Under these arrangements the lock may be made as wide as is desired, and may be operated by one man.

193,897. SHAKING AND DUMPING GRATES. Harry Rogers, Janesville, Wis.

Each shaft is provided with a series of fingers or bars made circular on top and forming the grate surface. Each finger is eccentric to the shaft in a horizontal direction, and with the bars in each series alternating with each other in their location upon the shaft, so that the long end of one finger will correspond with the short end of the finger on the next adjoining shaft, whereby on shaking the bars a zigzag opening would be made in an unbroken surface of a coal fire.

193,899. SULKY PLOW. Geo. H. Smith, Rockford, Ill.

The plow beam is suspended from a vertical shaft, upon which it vibrates vertically and rotates horizontally. The shaft has a geared rack at one side with studs which fit into annular grooves upon the shaft. A crank screw elevates the shaft in a socket. The latter is cast with a bed-plate which pivots upon another clamped to the axle. These devices serve to level the plow or move it to or from the land.

193,929. DOUBLE HYDRAULIC ELEVATORS. H. Davies, Newport, Ky.

The elevator trunks are divided into horizontal compartments corresponding to the stories of the building. The elevators are alternately raised or lowered by hydraulic rams automatically actuated by valve mechanism. When the doors are open the elevator is prevented from moving.

193,934. EVAPORATING PANS. Wm. M. Dixon, Riceville, Tenn.

In this pan for concentrating the juice of sugar cane, sorghum, &c., the heat is directed to the central compartment, and the juice when done is skimmed, and run successively and by degrees into the separate communicating chambers, in each of which it is again skimmed, until it gets to the last in a cool and clarified condition and is drawn off. The cooling compartments are arranged around the central one, and beyond the fire, so that the syrup may be transferred from the first cooling chamber to the last without crossing the line of heat. The walls or partitions of the central chamber are higher than the outer walls of the other chambers, and all the walls are made of wood, or of metal below and wood above. The entire bottom is of metal.

193,984. ROLL GRINDING MACHINE. J. Megaw, Philadelphia.

The outer end of the reciporcating grinding carriage is suspended by a horizontal hinge, so that the axis of the grinder is constantly changed with relation to the axis of the roll, being ground by the rising or falling of the grinder as it passes up or down a jointed and double incline track way on the side of the main frame. The inclination of the track way is varied by a screw.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, SEPTEMBER 15, 1877. NO. 11.

Fig. 1.—STEAM CRANES ON QUAYS AT HAMBURG, GERMANY.

HARBOR IMPROVEMENTS IN HAMBURG, GERMANY.

The improved means of international communication at the present time have increased commerce, and the interchange of productions of all countries, to an extent that would hardly have been imagined by the boldest minds among our forefathers. In our large seaports, either viewing the movements of the numerous crafts of all sizes and builds upon the water, or the busy scenes at the wharf, where loading and unloading goes on forever, this fact impresses itself more on our minds than elsewhere.

The ways of commerce have all undergone a radical change in modern times. Formerly a seaport really formed a department and warehouse for all goods for imports and exports, and a merchant there really bought and sold all the goods handled by him. Now, in our days of steamships and railroads, nearly every large dealer in inland cities treats direct with distant and foreign merchants, and the business man of the seaport only attends to the shipping and forwarding of the goods to and from steamships and railroad cars. This state of things makes it important to avoid break of bulk, and thus we see the railroad cars brought directly to the steamship, to exchange their through freight. The large steamships, now carrying all important freight, make their trips with regularity, and cannot afford to be detained longer than barely necessary; thus appliances for discharging and loading them quickly are imperatively necessary, and in most ports this work is carried on night and day.

Many of us have heard of or even seen the immense basin docks of Liverpool, stretching along the river-front for miles, all built of stone or granite, and their quays covered with immense sheds. Steam or hydraulic cranes facilitate the handling of goods, and railroad cars or common trucks stand in waiting to receive and carry them to their destination.

The city of Hamburg, the most important seaport of northern Germany, has, in the last few years, spent several millions in building extensive quays with all modern improvements, which, although not so pretentious as the Liverpool docks, yet afford an interesting study, not only to engineers, but also to merchants and others interested in the progress of commerce and navigation.

On page 122 is given a general perspective view of the entire work; in front appears an immense warehouse, in shape of a hollow square, which forms the end of this quay. This warehouse has six floors, and has room for 15,000 tons of goods. Beyond, the quays extend on both sides for a length of about 3,500 feet, being covered with sheds, and fitted all along with portable steam cranes, which are shown clearly in the illustration which heads this article. Between the sheds in the centre of the quay are several railroad tracks, and a good broad macadamized road for ordinary traffic. On the left side of Fig. 2 a quay, similarly arranged, but about 4,000 feet long, is seen; back of the sheds are railroad tracks, which some distance further up unite with those of the central quay, and are connected with the Hamburg-Paris, the Hamburg-Berlin, the Schleswig-Holstein and other railroads running into Hamburg.

Fig. 1 gives a good view of the cranes, which are of a rather novel construction, being similar to hydraulic cranes in transmitting the motion of the steam piston direct to the hoisting chain, increased lift being obtained by passing the chain over several sets of pulleys. The cranes are entirely self-contained, being mounted complete on a truck, and can thus be transported all along the quay front on rails, as seen in the cut. Most of the cranes have a lifting power of 1 to 5 tons, but there are several for 10 to 15 tons, and one even for 30 tons.

To give an idea of the work done on these quays, it may be stated that in 1875 there were 1426 steamers (medium and large sea-going vessels) discharged and loaded. The entire freight handled in the same year was 600,000 tons, of which 300,000 tons were moved by railroads, 80,000 by trucks and carts, and 220,000 by lighters and barges. Steamers are generally discharged and loaded in three or four days, but in case of necessity this work has been performed in 24 hours. As Hamburg is a free port, no delay occurs on account of custom regulations and similar obstructive formalities.

The above description naturally leads to reflections on the arrangements for the same purpose in Philadelphia, and it must be admitted that there is room for improvement. If we want to keep and increase our shipping and commerce, we must provide convenient and cheap facilities, otherwise we will not be able to compete with New York, Baltimore, Boston and other seaports.

The further consideration of this subject may be taken up again in a future article.

J. HAUG.

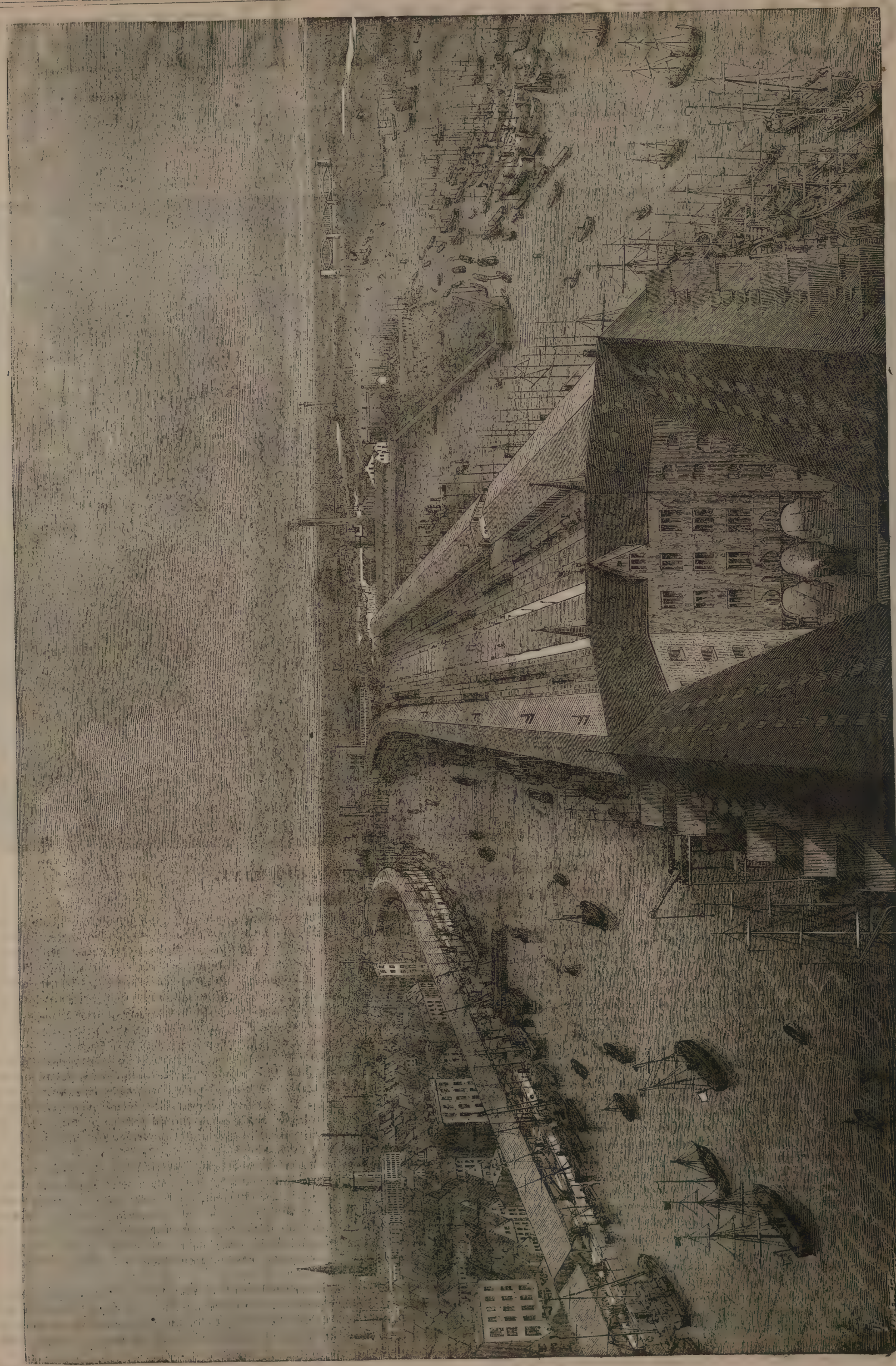

Fig. 2.—PERSPECTIVE VIEW OF HARBOR IMPROVEMENTS AT HAMBURG, GERMANY.

The Polytechnic Review:

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

WILLIAM H. WAHL, PH.D., ROBERT GRIMSHAW, PH.D., } EDITORS AND PROPRIETORS.

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January 10th, 1877.

COINCIDENCE OF THOUGHT AND EXPRESSION.

Under the above caption we might very well compose a treatise as to the causes and conditions operating upon the human mind in the evolution of thought; with particular reference to the "editorial" on the "History of Chemistry," published in the *Manufacturer and Builder* for September, and one *verbatim et literatim* the same, appearing in the THE POLYTECHNIC REVIEW under date of March 10, 17, and 24. The operating causes appear to have been similar in the case of the article on Artificial Stone, which recently appeared in the *Manufacturer and Builder*, and in the publication of which THE POLYTECHNIC REVIEW preceded the New York journal mentioned by some months. Our cotemporaries can well afford to credit us for articles borrowed.

ZINC.

This metal, which has long occupied a prominent position in the arts, is very widely though not very abundantly distributed. It has been found but very rarely in the metallic state, but occurs mostly as silicate, (calamine) carbonate, (zinc spar), sulphide, (blende) and oxide.

The ores of zinc are known to have been employed in very ancient times in the production of brass, and they are referred to under the name of *cadmia* by Aristotle and Pliny. The word zinc to indicate a particular metal is first employed in the 15th century by Basilius Valentinus. Paracelsus, however, is the first to describe its properties, although he gives no explanation of the methods by which it was made. The metal was first produced on the commercial scale in England in 1730. It is obtained by the reduction of the oxide with coal, and the volatilization of the metallic zinc. As obtained commercially the metal is never quite pure, but, according to the locality from which the ores have been obtained, and the care employed in their reduction, it contains a greater or less percentage of impurities, of which we may enumerate, cadmium, iron, lead, manganese, copper, tin, antimony, and at times nickel and cobalt; arsenic and sulphur are frequently contained. The pure metal may be obtained from the commercial article by fractional distillation. The first portions of the distillate will contain the more volatile impurities cadmium and arsenic, and if the distillation is not carried too far, the less volatile metallic impurities will be retained in the residue.

Metallic zinc possesses the following properties:—It has a bluish-white color and a coarse crystalline texture; when, however, it is cautiously heated to just the temperature required for its fusion, and is then quickly cooled, its texture is finely crystalline. It has a specific gravity of 7·2 (water = 1). It is tolerably hard; can only be filed with difficulty; it is brittle, and breaks readily under blows of the hammer, along lines formed by its crystals. Between the temperatures of 212° and 300° Fahr. it is malleable and may be rolled into sheets. At this temperature also it may be drawn into wire. At the temperature of 460° it becomes quite brittle again, so that it may be crushed to powder. Its conducting power for heat is represented by 64, silver being 100; for electricity, 27·39 (silver = 100). The metal fuses at a temperature of about 770° Fahr., and at bright red heat burns in the air with an intensely bright bluish or greenish flame, and the production of dense volumes of white fumes (zinc oxide).

Exposed to the atmosphere, the metal soon loses its metallic lustre and covers itself with a grayish film of suboxide. This thin skin protects the underlying metal from further oxidation. Zinc produces, in boiling water, a slight decomposition of the water with evolution of hydrogen, but the addition of a small quantity of acid, sulphuric or hydrochloric, (or even acetic and tartaric) causes an energetic decomposition and the rapid evolution of hydrogen at ordinary temperatures, which action is continued until the metal has entirely disappeared by solution.

A powerful electro-positive metal, zinc precipitates from solutions of the salts of arsenic, antimony, tin, cadmium, copper, lead, silver, etc., the elements named, in the metallic state, the zinc substituting the corresponding metal in the solution. This action of zinc has been practically made use of in protecting surfaces of the reducible metals from oxidation, by bringing them in suitable contact with zinc; which last, by the galvanic influence it calls into play, is oxidized, and the metal in contact with it preserved unaltered. The so-called galvanizing of iron pipes, vessels, etc., which is accomplished by plunging the surfaces in question into a bath of molten zinc, by which a covering of the latter metal adheres to them, is designed for the purpose of protecting the iron from rusting. (This subject will be fully treated of in another article.) The application of zinc in a variety of ways to the copper-sheathing of ships has the same object, the copper being protected at the expense of the zinc.

The metal finds extensive application in the arts in the form of sheet zinc for the covering of roofs, etc., and in form of galvanized iron, as above noted, has attained an immense popularity, especially in this country, where it is employed for vessels of almost every description of household use, for pipes, railings, telegraph wires, screens, ornamental cornices for buildings, etc., and for a great variety of outdoor uses, where the strength of iron is desired, but where iron would be too rapidly rusted, if unprotected.

It furnishes zinc white, a substitute for lead paint, which is more or less largely used, but, it should be remarked, is not equal to lead in covering power, though it has the advantage of not darkening with age from the action of sulphurous vapors. It should also be added that zinc expands and contracts strongly under the influence of change in temperature, and that it becomes quite brittle in the cold. Zinc sheet, therefore, must be allowed plenty of play room. It should be attached either with nails of zinc or of strongly galvanized iron, as iron nails will rapidly rust out. As we have seen above, zinc is readily attacked by even the weakest acids, and as its salts are poisonous, vessels of galvanized iron should not be used in the preparation of articles of food.

In the laboratory of the chemist, zinc is largely used for the preparation of hydrogen and for reducing purposes, for which uses it is of course of important that the metal should be quite pure.

We will treat of other matters relating to the technical uses of zinc in a subsequent article. W.

THE METRIC SYSTEM.

A FAMILIAR EXPLANATION AND A POPULAR SUGGESTION.

II.

*Liquid Measure and Dry Measure.**—If, as has, we hope, been clearly shown by making the yard a metre in length, and its divisions and multiples by tens, our table of long measure becomes as simple as our table of money, can our tables of liquid and dry measure be similarly simplified? At present they are "confusion worse confounded," a medley of gallons, quarts, pints and gills—four kinds of each! There is the wine quart, having a capacity of 57¾ cubic inches; the beer quart, containing 70½ cub. in.; the dry quart, about 67⅕ cub. in.; and the imperial quart, about 69⅓ cub. in. Gills, pints and gallons, also in quadruple *disproportion*, and bushels nearly as bad. The beer barrel contains 36 gallons of 282 cub. in. each; the wine barrel 31½ gallons of 231 cub. in. each; the petroleum barrel 40 wine gallons. There are 32 dry quarts in the Winchester bushel, used in this country, and 32 imperial quarts in the bushel used in Canada and other English colonies, as well as in Great Britain and Ireland. Thus the liquid and dry measures, legal and in most general use in the United States, differ from those of all other countries.

Every intelligent American must feel a sense of shame that anything so foolish and absurd as our systems (?) of measures of capacity should be tolerated among us. Nor will he wonder that combinations of men take advantage of the multiplicity of standards to serve their own purposes. One instance must suffice. The middlemen who buy of farmers the milk for the supply of Philadelphia buy only by the dry quart of about 67⅕ cub. in., while they sell to city families by the wine quart of 57¾ cub. in. The same is said to be true of other large cities, and the common charge of diluting the article is, therefore, not the only one to which these vendors are obnoxious.

Congress has not been altogether unmindful of the subject, for eleven years ago an act was passed "To authorize the use of the metric system of weights and measures," in which it is declared that "from and after the passage of this act, it shall be lawful throughout the United States of America to employ the weights and measures of the metric system, and no contract or dealing or pleading in any court shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights and measures of the metric system." A joint resolution of both houses was also passed "To enable the Secretary of the Treasury to furnish to each State one set of the standard weights and measures of the metric system," which provides "that the Secretary of the Treasury be and is hereby authorized and directed to furnish to each State, to be delivered to the governor thereof, one set of the standard weights and measures of the metric system, for the use of the States respectively." Approved July 27th, 1866.

Among the standard measurements were not only the metre or yard of our new long measure before described, but also the litre or French quart, having a capacity of 61.02 cub. in. This quart is equal to a cube, the length, breadth and thickness of which are exactly one deciyard of the same long measure—about 3¼ cub. in. more than the wine quart, and about 8¼ less than the imperial quart; a "happy medium" between the two, which the people, ratifying the action of Congress, should substitute for the quadrilateral of quarts with which we are troubled.

The division of the new quart into tenths, hundredths and thousandths, and its multiplication by ten, hundred and thousand, may be expressed by one table, including dry and liquid measures, which we may call the decimal

TABLE OF LIQUID AND DRY MEASURES.

10 milliquarts.....1 centiquart.	10 quarts.....1 dekaquart.
10 centiquarts.....1 deciquart.	10 dekaquarts.....1 hectaquart or barrel.
10 deciquarts.....1 quart.	10 hectaquarts or barrels.....1 cubic yard

The new barrel of 100 quarts has thus a capacity of 6102 cub. in.

Tables of Weights.—Had our three tables of weights, known as the Avoirdupois, Troy and Apothecaries', been designed for the purpose of perplexing the learner,

* The new table of square measure is easily made from that of linear, by prefixing 100, thus:—100 square milliyards = 1 square centiyard, &c.; the new table of cubic measure, by the prefix 1000, thus:—1000 cubic milliyards = 1 cubic centiyard, &c. Land measure, not being used in the ordinary transactions of trade, either domestic or foreign, is for the present omitted.

they could scarcely have been worse. He finds that 16 drachms make an ounce according to one table, and 8 drachms according to another, and hence concludes that the ounce of the former weighs just double that of the latter. He is incredulous when told that the latter is actually the greater by 43 grains. He sees that one pound contains 16 ounces, another but 12, and he is positive that the latter must be exactly three-fourths of the former, when, to his great disgust, he is told that the relation is quite complex, viz., as 516 is to 700.

Different characters—ʒ and oz.—stand for precisely the same weight. One coal-dealer always sells by the "long" ton, another always by the "short," while a third gives his customer the choice.

The druggist buys his washing soda, epsom salts and cream of tartar by the pound of 16 ounces and puts up prescriptions by that of 12. His scruples are as mysterious as are the pennyweights of the jeweler, or the practice of calling a hundred pounds a hundredweight in one place and one hundred and twelve pounds by that name in an other.

To extricate ourselves from these absurdities of our tables of weights is not at first sight so easy as to reform our tables of length and capacity, because, while the metre differs but little from the English yard, and the litre from our quart, the kilogram, as the standard for what our most numerous class, the farmers and their families, have to buy and sell, is more than twice the weight of our avoirdupois pound, and therefore inconveniently heavy.

Again, the eye can grasp the "extension"—that is, the length, breadth and thickness—of an article of trade, and the mind accommodates itself more or less to a change of standard. But weight is an invisible property of matter, and when a standard of weight has been long and generally accepted by a people, the substitute offered for that standard must, in order to be cheerfully adopted, approximate to it. Hence, in the retail groceries of Paris one hears the customer call for so many demi-kilograms (half kilograms) of the solids he wants, instead of so many kilograms. The demi-kilo., as they abbreviate it, approximates in weight to the old French livre or pound, and is associated in their minds with it. The Germans—slow, perhaps, but generally sure—when taking steps to introduce the French system, adopted the half kilogram as the pound, and we are more and more confirmed in the opinion that their example ought to be followed in this country. Perhaps it was a statesman's forecast which caused a Secretary of the Treasury to include a half kilogram among the standard weights of the metric system sent to the governors of the States under the joint resolution above quoted.

The demi-kilogram weighs 7716 troy grains, about $1\frac{1}{10}$ avoirdupois pounds. The divisions and multiples, according to the decimal system, are just one-half of the corresponding ones in the French table, and may be converted into them with the greatest facility. For the convenience of the apothecaries and others requiring small weights, the term "grain" may be retained and applied to the one-ten-thousandth part of the new pound; and, as a concession to the popular use and application of the word "ton," it also may be retained and made to stand for 2000 new pounds, about 2206 avoirdupois pounds, and therefore between a "long" ton and a "short" one. As thus constituted, the pound being the weight of a half quart (new) of distilled water, at the maximum density, the following would be the new decimal

TABLE OF WEIGHTS.

10 grains.....1 millipound.	10 pounds.....1 dekapound.
10 millipounds.....1 centipound.	10 dekapounds.....1 hundredweight.
10 centipounds.....1 decipound.	20 hundredweight.....1 ton.
10 decipounds.....1 pound.	

Congress has legalized the metric system; the people of any State, through their State legislature, may adopt the system at any time, and when adopted by one State the others will follow. Who among the intelligent members of the thirty-eight legislatures will take the initiative next winter? The only popular objection to the French system—the hard foreign names—we have sought to remove, retaining the decimal feature.

Friends of the reform are invited to get up and circulate petitions for it. We now ask the press of the country to aid the good work by transferring to their columns the two condensed articles we have contributed, and drawing attention to the subject. With editors for teachers, the people will soon call upon their representatives for the reform; the representatives must obey, and, lo! the work is done.

ALFRED L. KENNEDY, M. D.

Polytechnic College, Philadelphia.

THE MANUFACTURE OF POCKET CUTLERY.

It has been deemed, without reason, that the manufacture of pocket cutlery is one that is environed with difficulty in this country, from the trouble of obtaining proper workmen to compete with the skilled labor of England, that has made her manufacture of cutlery one of the prominent sources of her commercial progress, and given her workmen and their products the foremost place in the markets of the world. This opinion is not sustained by the facts; we can and do make as fine specimens of cutlery as ever came from Sheffield, possessing, as we do, as competent workmen and using as good material as those employed and used by the most celebrated English manufacturers. The best pocket cutlery blades are hand-forged, not cut or stamped out. They are usually made in three heats, perfect in form when leaving the anvil, except the beveling of the backs of the blades, to guide engaging blades when being closed into the handle, which bevel is formed by grinding. The steel used is generally Wardwell's (English), and is heated in a fire of coked coal, the blades being forged on an anvil set with dies, the anvil and hammer being of peculiar form. A good forger seldom uses a gauge, the perfection of the form of blade being assured by practice. An experienced workman will turn out about thirty pocket-blades or forty pen-blades per hour. When the blades come from the forger they are "choiled" or filed to make a nick between the blade and tang, which is then ground and stamped with the company's trademark. The blades are then hardened and tempered two at once, being heated in a coke fire, plunged in water, and drawn over a fire. This requires a practiced hand in order to secure evenness of temper. If the blades are sprung in the operation, they are straightened by blows from the pœne of a hammer, the blows being given on the concave side, just as a machinist straightens a casting by expanding the material on the concave or contracted surface. The next operation is grinding, first on a Wickersley stone from England and then on a Nova Scotia stone. The "glazing" or finishing of the blades is not done until after the blades are put into the handles and the knife becomes an entity. This finish is produced on emery-wheels, and finally on wheels of lead fed with cake emery and crocus. The "scales" or linings of the handles are made of sheet iron, brass, or German silver, punched in presses from the sheets. When bolsters are used (as the metal finish at the ends of some handles is called), these bolsters or ears are formed in drop-presses with dies, a teat or projection being formed on the inside of each at the same time, which enters a hole in the scale and is secured to the scale by a drop-press, firmly riveting the two together. The central portion of the scale is indented or recessed from the outside, to leave the upper portion somewhat projecting, in order to bring it in close contact with the material forming the outside of the handle, to make a perfectly close fit. The springs are punched in dies from sheet steel, and then dropped between smooth dies to make them perfectly flat, removing the rounding of one side and the burring of the other. The scales, blades, springs, and the roughly-sawed out scale covers, are then assembled, placed in gauges or gigs, and the holes for riveting the handles, scales, and springs, and that for the pivot of the blade, are drilled, and the parts temporarily united by wires in place of the rivets. The knife then goes to the cutter, who tempers the springs, rivets the parts, and completes the knife except the final polishing and the "setting" or honing the blades. The springs are heated over a charcoal fire, a dozen at a time being strung on a wire. The recesses in the handles to receive the name-plate are cut by a double rotary cutter or two minute cutters rotated rapidly, the cutters being connected by a spring and being guided by a hole of the proper shape made through a steel template. Shoulders on the shanks of the cutters gauge the depth of the cut. The final finish of the handles is done by rotten-stone on wheels of walrus hide. The handles are of mother-of-pearl, tortoise shell, ivory, buffalo horn, stag horn, cocoa wood, bone, and ebony. The buck horn or stag horn handles are made principally for the Southern market, in which section of the country they are preferred for even the finer sorts of knives. The rivets which form the pivots of the blades are either of iron wire or German silver wire. Some idea of the extent of the manufacture of pocket cutlery in this country may be obtained from the fact that at a single establishment in Connecticut* no less than four hundred and seventy-five varieties of pocket knives are made, from the pocket pruning-knife to the smallest nail-cleaner.

J. H. L.

BASKET MAKING.

Machinery has largely taken the place, in modern times, of much of the hand work in all departments of industry, performing the same labor and retaining the same title for the work—manufacture or hand-making. To this statement the former, essentially hand-work of basket making, is no exception. Formerly every process, from the splitting of the material or the separation of the splints from the green log by beating with a mallet or hammer, to the weaving of the basket, determining its form by the eye, was done by hand; but now little is left for the sheer skill of the worker except the mere act of weaving the splints. The limit of materials also has been enlarged, the osier even finding a successful rival in the core of the ratan of commerce, after the silicious outside has been removed to form chair seats and backs and other articles of cane work. For splint baskets, the white or gray oak and the rock or hickory elm is mainly used, the splints being shaved from a bolt or plank by means of a reciprocating knife driven by power. The bolt, of sufficient length for the size of basket, and of the requisite thickness to produce the width of splint desired. is secured by dogs in a machine, in the same manner as a log for sawing into boards, and is moved by a sliding carriage against a blade set in an iron frame precisely as the iron of a plane. The knife stands at a vertical angle of about eighty degrees, to give a shearing cut, and is set to gauge the thickness of the splint. The bolt is carried past the knife by means of crank and pitman, belt and fly wheel, and the splint is shaved off, being more or less perfect as the grain of the bolt corresponds with the line of cut and the material is more or less free from knots or knurls. Unless the splints are very thick they are woven dry, but the bottom and top rims are steamed or soaked before being fitted to the formers, which are simply shapes of plank. Similar shapes, or frames, are used in the weaving of the splints, the frames forming the interior of the basket and, in use, being suspended on a pivot for the convenience of the workman. Flat covers are simply hand-woven of sufficient dimensions, placed on the finished basket, marked with pencil and cut to fit. Tinned annealed iron wire is largely used to secure side handles and strengthen the union of the body of the basket with the bottom and the top rim. This is employed in the form of staples or rivets, the staples being wound in a lathe on a flat iron rod, similar to the formation of a coiled spring, and the staples separated by being cut apart by a rotary cutter. The holes for the staples and rivets are drilled in a machine, and the riveting or clinching done in a press. Split ratan cores, and also the full ratan split, are also used for making the baskets, the weaving being done like that of the splints. To the usual large variety of baskets formerly made has lately been added the English hamper, some of which are oblong, like gigantic champagne baskets, and others upright with a capacity equaled only by the Saratoga trunk. For picnic parties, and also for ordinary traveling purposes, these have become deservedly popular, as they are handy, light, and not liable to the wrecking of the baggage-smasher. Berry baskets, for the transportation of strawberries, raspberries and other small fruits, are made of "whitewood," the splints, or rather veneers, being peeled off a cylindrical piece, as some veneers are made. The open sides and solid bottom are in one piece, the opened portion being cut in a press. A press with dies also forms the basket at a single operation, when the rim is added and secured by rivets. Not the least interesting thing about the berry-basket manufacture is the rapidity with which they are made, a judicious division of the labor insuring a speed that is quite surprising and rendering possible their extraordinary cheapness.

JESSE H. LORD.

*The Connecticut Cutlery Company, Naugatuck, Conn.

HOW TO DETERMINE THE QUALITY OF STEAM.

Instances frequently occur when it would be very important to steam-users to ascertain the amount of water primed by a boiler, or, in other words, the quality of the steam furnished by a boiler; yet the necessary experiment is seldom made, owing to the mistaken notion that it involves technical difficulties beyond the scope of ordinary practice. Below are described the different methods available for determining the quality of steam; and it will be seen that, although the solution of the problem requires great care and the use of elaborate instruments when scientifically correct results are attempted, it may yet be reached, even with primitive appliances, accurately enough for all practical purposes.

The first method which naturally suggests itself is to supply steam from the boiler to be tested to an engine running under a constant load, or at least under a load of which all the variations may be observed accurately. The weight of the steam used by the engine may then be estimated (admitting that the consumption will vary with the load), and the difference between that and the amount fed to the boiler will represent the amount of water primed. It is evident, however, that great difficulties must be experienced in making proper allowances for losses by condensation, leaks, &c., and also in observing and recording accurately the variations of the load.

Another method is based on the well-known fact that steam is free from the substances which it held in solution while in the state of water; in other words, if a boiler be fed with water holding, say, common salt in solution, the steam, if dry, will contain no salt; whereas the presence of salt in the steam will indicate priming. The following is the mode of operating: the boiler is filled up to the normal level with say 10,000 lbs. of water, containing 4 per cent. of salt; it is then fired and worked for a certain period of time, after which the water left in the boiler (10,000 lbs., as the level is kept the same) is found to contain 21 per cent. of salt. We will assume that the amount of water fed to the boiler during the experiment to replace the amount evaporated (or primed, if any) was 50,000 lbs., said feed-water containing 5 per cent. of salt. Then the amount of salt lost by the water in the boiler, through priming, is evidently $10{,}000 \times 0.04 + 50{,}000 \times 0.05 - 10{,}000 \times 0.21$.

Again, if we call p the proportion of water in the steam, and if we assume that the average concentration in the boiler during the test was the mean between that at starting and that at stopping, or $\frac{0.04+0.21}{2}$, then the amount of salt carried out of the boiler by the water primed is represented by $p \times 50{,}000 \times \frac{0.04+0.21}{2}$. Having now two expressions for the amount of salt carried out of the boiler, we can deduct therefrom the unknown quantity p, viz.:

$$p \times 50{,}000 \times \frac{0.04+0.21}{2} = 10{,}000 \times 0.04 + 50{,}000 \times 0.05 - 10{,}000 \times 0.21.$$

$$p = \frac{400 + 2500 - 2100}{6250} = \frac{800}{6250} = 0.125.$$

Which means that in this example the amount of water primed was 12½ per cent.

Although the above method, which is very ingenious, is also simple (as for ordinary purposes the salinometer affords suitable means of gauging the solution of salt without resorting to a chemical analysis), it presents an inherent chance of error. The presence of salt or of a foreign substance in the water affects the proportion of priming; therefore, whereas accurate results may be obtained in cases where the water usually fed to the boiler is sufficiently saturated to make it available for the experiment, the results found with boilers ordinarily using purer water, although quite accurate in themselves, will not represent the ordinary performance of the boilers. Again, when carrying *very* high pressure of steam, some of the salt may be volatilized and carried over with perfectly dry steam.

It has also been attempted to separate the water primed from the steam mechanically. A sudden short bend in a steam-pipe will check the velocity of the flow, and owing to their difference in specific gravity, the steam and water will separate. It is claimed that this separation will be effected more completely if the deflection of the current of steam takes place over a sheet of water. This may be accomplished by running the steam into the upper part of a closed reservoir or trap half filled with water, the inlet and outlet to which are so disposed as to change the direction of travel of the stream.

The objections to this method are, first, that the water entrained with the steam is in so divided a state that there is no certainty of their being completely separated; second, that an allowance has to be made for the dry steam condensed in the trap. This correction can be made by connecting the trap with the boiler for a given period of time and maintaining a pressure equal to that used while running the experiment—no steam, however, being drawn through the trap. The increase in weight of the water in the trap shows the condensation which has taken place during the given time.

The three methods described above present difficulties—especially the first one—which prevent them from being used in daily practice with reasonable chances of success. They have been mentioned here to illustrate the different sides of the problem, and to show by their very disadvantages the superiority of the calorimetric process of investigation.

Steam at a given pressure contains a given known number of units of heat. If more, it is superheated; if less, it is moist. (The dry steam containing the known number of heat-units due to the pressure, the water primed only the sensible heat, the mixture of the two will contain less *heat* than the dry steam.) The calorimetric method consists in measuring the heat in the steam. This is accomplished by condensing a certain weight of steam in a vessel in contact with a certain weight of water the temperature of which is thereby increased; the number of heat-units imparted to the water (its weight multiplied by the increase in temperature) represents the amount of heat liberated by the steam in condensing and then cooling down to the final temperature in the vessel.

For instance, let us suppose that 10 pounds of steam at 70 lbs. of pressure (84.68 total pressure) have been condensed in a vessel in contact with 500 lbs. of water, which are thereby heated from 60 to 82°. Then we may say that 10 lbs. of steam, to condense and cool down to 82°, have liberated $(500 \times 22) = 11{,}000$ heat-units, or that 1 lb. of steam has liberated 1100 heat-units. Again, the water derived from the condensation of the steam still contains 82 heat-units, so that the total heat of the steam operated upon is 1182 heat-units. Tables of properties of steam tell us that saturated steam at 70 lbs. pressure (84.68 total pressure) contains per lb. 1210.26 heat-units. In the above case, then, the steam was moist, as it did not contain the number of heat-units due to saturated steam. Had we found, instead of 1182, a number of heat-units larger than 1210.26—say 1220—this would have indicated superheating.

To determine from the number of heat-units as ascertained above the proportion of water primed requires but a very simple calculation. Let us return to the above example, and say that we have found 1 lb. of steam to contain 1150 heat-units; let us call S the fraction of that 1 lb. which is dry steam and W the fraction which is water primed; then

$$S + W = 1. \tag{1}$$

Water at the pressure of 70 lbs. contains the sensible heat due to the pressure, or 320.4 heat-units; W pounds of water contain $W \times 320.4$ heat-units; likewise S pounds of steam contain $S \times 1210.26$ heat-units, 1210.26 being the total heat in dry steam at 70 lbs. But we have found that one pound of the steam we operated upon contained 1182 heat-units, therefore we can write

$$W \times 320.4 + S \times 1210.26 = 1182. \tag{2}$$

We can put the first equation in the form

$$W = 1 - S,$$

which value of W we will substitute in equation (2), which becomes

$$(1 - S)\ 320.4 + S \times 1210.26 = 1182.$$

$$320.4 + S\,(1210.26 - 320.4) = 1182.$$

$$S\,(1210.26 - 320.4) = 1182 - 320.4.$$

$$S = \frac{859.6}{889.86} = 0.9659.$$

and

$$W = 1 - S = 1 - 0.9659 = 0.0341.$$

In this case, then, the steam furnished by the boiler contained 96.59 per cent. of dry steam and 3.41 per cent. of water; the proportion of water primed, to dry steam, being 0.0353 to 1.00.

The above method of testing the quality of steam was applied at the Centennial Exhibition in the competitive trials of steam boilers, and was carried out successfully, although with a very simple apparatus. The calorimeter tank consisted of a plain wooden barrel provided with a suitable stirring apparatus and placed on a platform scale. A drain-pipe was attached to the bottom of the barrel, and provision was also made for filling the barrel with water from the hydrant. Into a vertical portion of the steam-pipe of the boiler, and close to the stop-valve, was screwed a short horizontal piece of three-quarter-inch pipe, which was driven in till it touched the opposite side of the steam-pipe. A row of small holes were drilled on one side of the three-quarter-inch nipple, and in attaching it care was taken that the holes should be turned downward, the object of this contrivance being to catch steam from all portions of the ascending stream in the steam-pipe. To the three-quarter-inch nipple was attached a three-quarter-inch pipe, felted throughout its length, and running out to within a couple of feet from the calorimeter barrel. At the end of this pipe was attached a half-inch globe-valve, and beyond that was fastened a one-inch hose about five feet long.

The observations were taken in the following manner: the barrel was filled with water from the hydrant, and the weight and temperature of the water and the pressure of steam were noted. The globe-valve on the three-quarter-inch steam-pipe was opened just enough to puff out all water which might have collected in the pipe; then the end of the hose was dipped into the water in the barrel and the globe-valve was opened wide. The stirring apparatus was worked steadily so as to ensure a thorough distribution of the heat throughout the mass of water. When the temperature in the barrel had been raised sufficiently, the steam was shut off and the temperature was noted carefully. The hose was removed after allowing it to drip over the barrel, and the final weight was noted. The steam pressure was also noted upon completing the experiment, and the mean between that and the initial steam pressure was taken as the average during the observation.

In making the calculations, allowance was always made for the stirring device; its weight multiplied by its specific heat being in all cases added to the water in the barrel.

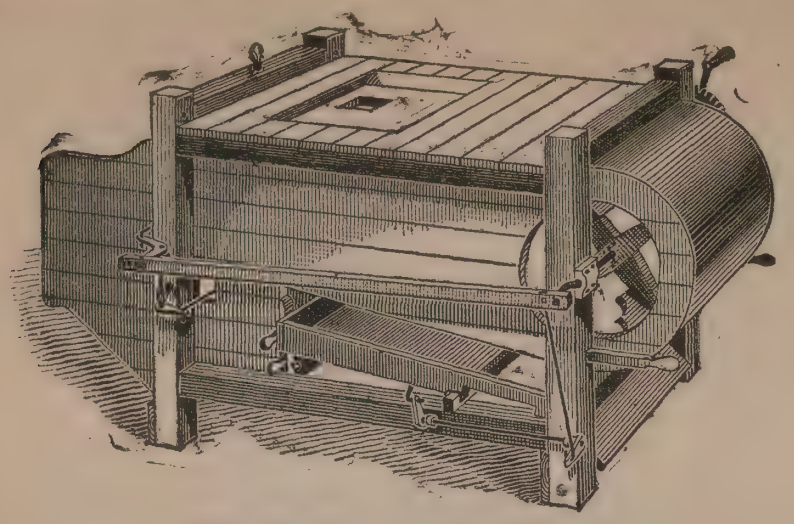
By using a wooden tank, the error due to radiation through the sides of the calorimeter is reduced to a minimum. Again, by heating the water as many degrees above the temperature of the surrounding atmosphere as its initial temperature was below, the loss and the absorption of heat are made to compensate.

Therefore, in determining the quality of steam by the calorimetric method, and proceeding as described above, it only requires care in reading the weights and temperatures to ascertain the total heat contained in a pound of steam, and therefrom the degree of superheating or the percentage of moisture.

E. M. HUGENTOBLER.

THE WILSON BELT HOOK.

The accompanying cut illustrates a device intended to supersede the lacing of belts. It consists of a metallic plate furnished with projections or teeth (likewise of metal) which pass through corresponding apertures made in the belt, and are clinched on the inner or running side of the same. The position of the teeth is alternate, as shown in the illustration. Not knowing where any of these "hooks" are in use, we cannot speak of their efficiency.



IMPROVEMENT IN FANNING-MILLS.

[Patented July 11th, 1876, by Charles Saunders, of Cape Vincent, N. Y.]

This invention consists of an improved feed apparatus; also, an arrangement of chaffing, screening, and separating shoes independently of each other, for regulating each according to its needs, and for working them so as to counteract the shocks of one by the other; and also for adjusting contrivances for regulating the inclination of the screens.

A is the hopper, in the bottom of which is a hole, *B*, through which the grain falls on to a shoe, *C*, attached to the chute-board, *D*, of the chaffing-shoe, *E*, so as to be vibrated by it, and being suspended by the cord, *F*, by which it is regulated to vary the feed. *G* is the screening-shoe, which is constructed, mounted, and operated independently of the shoe, *H*, which is also arranged to work independently of the chaffing-shoe, thus enabling each shoe to be vibrated more or less, as the work demands, and it also allows them to be so operated that the shocks of one will counteract those of the other.

The shoes, *E* and *G*, are worked by the upright crank-shaft, *I*, to which they are connected at opposite sides, so that they work in opposite directions at the same time, and thus neutralize each other's shocks. The crank-shaft, *I*, is connected with the fan-shaft by a pitman, *W*.

The screening-shoe is supported at the outer end on the cross-bar, *J*, one end of which is made to shift up and down to adjust the inclination laterally, to prevent the grain from flowing to one side, and the inner end is mounted on a vertically sliding-post, *S*, carrying a roller, *T*, at its upper end, which post is adjusted to a lever, *K*, for varying the descent of the screen, to make the grain pass off more or less rapidly. The shoe, *H*, is in like manner arranged on the post, *U*, and roller, *V*, adjusted by the lever, *L*, to vary its descent or pitch, for the same purpose. This shoe is connected to the cranked rock-shaft, *M*, which is worked by the connecting-rod, N, from the fan-crank.

The screen, *G*, has two sieves, from one of which the grain falls into the spout, *O*, to be carried out at *P*, and from under the separator-sieve, *H*, a spout, *Q*, discharges the smaller grain falling throught it, while that which passes off from the top falls into another receptacle.

CORRECTION.

THE NEW WATER WORKS AT DETROIT, MICH.—Our attention has been called to the fact that, under this title, an article appeared in the REVIEW of Aug. 4th, 1877, for which we failed to credit the *Engineering News*, of Chicago. We take this method of correcting the omission, which was accidental, and to acknowledge the courteous manner in which the matter was brought to our attention. [EDS.]

AN INTERNATIONAL SCIENTIFIC CONGRESS.

Abstract of a paper read before the American Association for the Advancement of Science, by PROF. GROTE.

The following is the chief part of the address of Prof. Grote, on "An International Scientific Service."

The time seems near at hand when, by an International Scientific Organization, the efforts of the best scientific minds of the more civilized nations may be joined for the solution of those problems which all are alike forced to grapple with, and which of themselves constitute the sufficient proof of a larger kinship than is expressed by the political boundaries of the globe. The benefit which humanity has derived from the formation of local societies for the advancement of knowledge, need not be rehearsed at this time. It is sufficient to say that they have proved admirable guides to the intelligence which produced them. The existing national associations in this country and in Europe are performing excellent work; but there are questions, to the answering of which their means are inadequate. Foremost among these there is that of the origin of our species. Indispensable to a correct habit of thought is the solution of this question, and its elucidation must be sought for in regions outside of those inhabited by the more civilized nations. (I would refer here to a paper "On the Peopling of America," read before the Buffalo Society of Natural Sciences, in February, and reprinted in *The American Naturalist* for April, 1877.) The various scientific explorations in Africa, Australia and the Polar Regions need coöperative assistance to realize the best results from the outlays, while the new knowledge they bring is the common inheritance of all reading peoples. Justice, then, would require that where all participate all should contribute. The plan of the International Scientific Service here provisionally proposed embraces the appointments of Commissioners by the civil governments of the world, whose deliberations would be the wisdom of the age, and whose recommendations would be respected by the legislative powers of the consenting and represented nations. Under their auspices all extra-limital astronomical, geographical and biological expeditions would be fitted out and directed to those places which would be more fruitful for the particular purpose. No longer would we be subjected to failures arising directly or indirectly from national prejudices. The difference in the mental faculties between different nations would prevent the loss in such a body of any possible suggestion the human intellect could afford.

From an economical point of view the outlay of the different governments for scientific expeditions would be lessened, and more effective work would be done.

The amount to be contributed would be less, because the expenses of any expedition to be decided upon by the Service would be made up by a quota from all the governments represented. The tendency to enlarge our application of good conduct is destructive to a narrow national sentiment; this is a sentiment which is only laudable when it tends to preserve a high morality, and it is weaker where the intellect is more advanced. When science takes hold of the brotherhood of nations, and calls upon them to undertake the solution of vital problems for the common good, there must surely be a glorious response. Of the existing sympathy between the nations we have many ready proofs. The Austrian Polar expedition is rescued by "foreigners," and America returns to England the ship she lost in Northern ice. The flag of the International Scientific Service should be made neutral by treaty, and would be held sacred by all.

As tending to break down social prejudice, as working in a direction toward both greater economy and greater result, I venture to lay the proposition before this Association that it memorialize Congress to appoint commissioners on the part of the United States, who would inaugurate the formation of such an International Scientific organization, and, by resolutions to be passed by this Association, invite a similar action on the part of kindred Scientific bodies in other lands as would influence their respective governments to assist in the enterprise.

It seems to me that some such step as I now speak of will eventually be taken. If the plan proposed be now acted upon, it will be at least a fitting thing that it was commenced by a country that protects the alien, and allows liberty to all its inhabitants to pursue their happiness. And it would be well for America to move in any matter that will create an active sympathy between the nations in scientific matters. For so will free institutions be the more readily preserved. Knowledge, of itself, brings a conduct that must give at last tolerance and good-will to all mankind. Obviously, then, any plan that will increase and diffuse our stock of experience should be adopted.

The course to be pursued by well balanced minds in handling questions as to the tendency of human conduct, seems to be plainly the cultivation of knowledge, so that we may get more light as to our proper behaviour.

ASBESTOS.

It is only quite recently that this substance has risen from being simply a mineral curiosity to a quasi-important article of commerce, on account of its peculiar qualities, being indestructible in fire or by acids, fibrous, and capable of being woven into cloth or made into paper, often as fine as the finest flax or silk, or like spun glass, although strictly a mineral product. In early antiquity it was made the subject of curious myths and strange tales bordering on the fabulous. Practically its sole use then seems to have been for winding-sheets in which to bury distinguished dead, or to be spun into napkins, which were used at exceptional feasts, and, to the astonishment of the guests, afterwards thrown into the flames, to come out intact, white and purified. At least Pliny mentions this; and it also would appear that Charles I. had table-cloths made of it, which he also was accustomed to throw into the fire for the same purpose. More recently stockings and a handkerchief were made in Elba of asbestos, as gifts to Napoleon I., while living there in exile. From time immemorial the peasantry where it is found, in various countries, have turned it to economical use as an incombustible lampwick, for which purpose its power of capillary attraction admirably qualifies it.

Common asbestos, more or less fibrous, but of a powdery, brittle quality, is abundant in most countries, and begins to find its way into some of the industrial arts, but largely mixed with other materials. The strong, long, fibrous sorts, varying in color from pure white to dark brown, thus far are only found in sufficient quantity for commerce in the Italian Alps, at elevations of several thousand feet, and often, for much of the year, buried under the snow. They occur in serpentine rocks in irregular veins, usually very narrow, and requiring much heavy labor and blasting to open. Sometimes, but very rarely, masses are found in one lump, weighing several hundredweight. More frequently the veins prove very superficial, and give out almost at once. Then, again, they can be steadily worked for years, as they extend or penetrate into the mountain. Although some of these have been yielding as much fibre as there was a demand for since they were first opened in 1871–2, recently the increased call has led to the discovery of new productive veins of the very best quality, which will increase the outcome from a few scores of tons per annum to several hundreds. But the price, heretofore varying from $250 to $500 a ton, according to the quality and condition of the fibre, threatens to grow firmer, owing to the new uses now springing up for it, mostly based on patents, whilst Italian capitalists themselves begin to see the importance of a mineral of which Italy has as yet a virtual monopoly, and are preparing to manufacture it on the spot where it is found into those goods which already find a steady and increasing demand.

These are, chiefly, steam-packing in the rope or loose form for piston and pump-rods and stuffing-boxes, and mill-boards for steam-joints, gaskets, man-hole plates, and a species of felting to cover boilers and steam-pipes. The ability of asbestos to resist an elevated temperature, moisture, friction, and flame itself, joined to its lubricating quality, specially recommends it for the above purposes. The chief objection to the manufacturer is that, when properly prepared and applied, it lasts too long. As a covering for boilers and pipes it saves 25 per cent. or more of the waste heat; and in domestic uses in cellars, to prevent loss of heat by radiation, it is found to reduce the temperature of the cellar 15°, while raising that of the house above 10°; *i. e.*, it saves the furnace or steam heat, and sends it where it is most wanted.

Asbestos lining or sheathing-paper, especially for wooden houses, for ceilings, floors and partitions, to prevent the spread of flames and make each room fireproof, is

now attracting attention in this country, and must recommend itself to builders generally, as rendering buildings not only safer from fires, but cooler in summer and warmer in winter, and free from insects that harbor in common papers. These papers are made in rolls of any thickness or length, and can be colored or printed with any desirable pattern. Fireproof boxes for shelves in shops can also be made of this substance, and scenery for theatres, if fabricated of it, would be impervious to flames.

The varieties of asbestos are quite astonishing to those who have not made a study of this mineral. No two localities seem to yield precisely similar fibre. In the cabinet of Mr. C. A. Wilson, Genoa, Italy, there are at least one hundred distinct varieties, from the Alps alone ; one specimen when taken out of the mine was five feet long, and weighed 700 lbs., of the most delicate cream color, and soft, like raw silk, after separating the fibres.

In this country the asbestos business begins to assume a prosperous condition, calling for increased supply of the crude article, whilst in Great Britain it is chiefly centred in a flourishing Glasgow company, which was the first to risk the novel enterprise of trying to utilize a well-known mineral that has waited more than two thousand years to become useful to men. In Paris it is begun to be adopted for civil and public registers in the form of a fireproof writing paper. Recently, patents have been taken out in this country and England to cover its use as a fuel-bed for petroleum in any sort of stove or engine furnace. It absorbs and retains the oil, its capillary attraction causing it to burn only on its surface, where it is under perfect control, and gives out an intense heat. By a simple arrangement the hydrocarbons can further be converted into gas-fuel, so it is claimed.

These facts would indicate that there is a business future for this mineral, and that new uses for it are likely to be discovered. The most beautiful varieties of the long, soft, flexible and extremely fine fibre, commonly known as "floss," and which are more abundant than the strong, tenacious fibres, yet await a call in the industrial arts.—*Iron*, x, 195.

AN ALGERIAN INLAND SEA.

As our readers are aware, several schemes have recently been before the public for the creation of an inland sea in North Africa, one of the most ambitious and most impracticable of these being the flooding of a great part of the Sahara. Another scheme which has engaged the attention of the French Government for some time is much more feasible and likely to be attended with good results. The Report of a Commission on the plan proposed by M. Roudaire for the creation of an inland Algerian sea was recently presented to the French Academy of Sciences by M. Favé, and as it contains several points of scientific interest, we propose to lay it before our readers.

Since the French domination was extended in the province of Constantine as far as the town of Biskra, the attention of several observers has been turned to the very marked depressions of the soil, which commence at about 50 kilometres to the south of Aurés, that is, to the border of the Sahara, and extending from east to west. M. Virlet d'Aoust supposed, in 1845, from the measurement of the slope of a river discharging into the Chott (or marshy lake) Mel-Rir, that the bottom of that chott must be below the level of the Mediterranean. In 1849 M. Dubocq, a mining engineer, proved, by a very numerous series of barometric observations, published in 1853, that singular anomaly, which Capt. Vuillemot confirmed in 1856. It was reserved to Capt. Roudaire, to render the fact incontestable and to determine the depth with almost complete accuracy.

After having taken for his starting-point the *embouchure* of one of the two small streams which fall into the sea at the bottom of the Gulf of Gabès, M. Roudaire traversed the steppe of Gabès, 46 metres high, then arrived at the depression of a chott the surface of which he estimated, at sight, at 5,000 square kilometres. He then reached, by crossing a second elevation of 45 metres, that of Kritz, the depression of the Chott Rharsa, situated to the east of the Chott Mel-Rir, from which it is separated only by two elevations of small height. These two slight elevations bound the Chott Asloudj, the surface of which does not exceed 80 square kilometres. The surface of the Chott Rharsa has been estimated at 1,350 square kilometres ; that of the Chott Mel-Rir, which has been surrounded by a polygon of levelling, contains 6,700 square kilometres. The three basins which from the Chotts El Djerid, Rharas, and Mel-Rir have not yet been surveyed in all directions ; but M. Roudaire has concluded from various observations that the mean depth of the two Chotts Mel-Rir and Rharsa must not be below 24 metres. The small Chott El Asloudj, which is intermediate, has a mean depth of only from one to two metres, which makes him regard it as a slightly elevated barrier between the two great lakes. If it be admitted that this barrier could be pierced by a trench of suitable depth, and that the water of the sea were led from the Gulf of Gabès to the entrance of the Chott Rharsa, the sea would fill that chott, as also the Chott Mel-Rir, and the depth of water would be sufficient in the two lakes for the navigation of all vessels. Articles of commerce could be transported thence to all parts of the world without any re-embarkation.

Such is the starting-point of a project for an inland sea which M. Roudaire has had constantly in his mind during all his labors ; he is confident that the execution is an easy matter, without allowing himself to be discouraged by any obstacle. The enterprise, supposing it to be realised, would certainly not present commercial advantages comparable in any respect to those resulting from the canalisation of the Isthmus of Suez. The products of Central Africa, transported by camels across the desert, do not seem to be sufficiently abundant to furnish freight for a large number of vessels. There is no doubt, however, that if the products of Central Africa had no longer to bear the expense of so long a carriage by land, their price would be notably lowered and their consumption increased. But indeed it would be impossible to estimate the benefits which in the future would result from the creation of such an inland sea. Considerations of another kind leave no doubt, M. Favé thinks, as to the improvements which would result from an inland sea covering 13 230 square kilometres, from a climatic point of view and in relation to the fertility of the soil.

Prof. Tyndall was engaged for some years in determining the action which the vapor of water exercises upon radiant heat. He has proved that even with complete transparency to light, the vapor of water absorbs radiant heat to a very notable extent. The vapor of water possesses that absorbent property much more than the air with which it is mixed, in however small a proportion ; and its absorbent power increases very nearly in proportion to its mass. Prof. Tyndall has not failed to bring out the influence which the invisible vapor of water contained in the air exercises upon temperature, both during day and night, and he has been able hence to draw immediate conclusions as to its influence upon the life of plants, After having measured directly the quantity of heat obsorbed by very minute quantities of vapor of water mixed with air in his experimental tubes, he feels authorised to speak thus : "Considering the earth as a source of heat, it may be admitted as certain that least 10 per cent. of the heat which it tends to radiate into space is intercepted by the first six feet of moist air which surrounds its surface." Prof. Tyndall hence draws this conclusion :—"The suppression, during a single night of summer, of the moisture contained in the atmosphere which covers England would be accompanied by the destruction of all the plants which frost kills."

It is not only the cold of night which is increased at the surface of the ground by the dryness of the air, but also the heat of day ; so that the variations of temperature produced in twenty-four hours are sometimes very great and very prejudicial to the vegetation of a great number of plants. We may apply these considerations to the region of the chotts, where M. Roudaire, in his expedition of 1874-5, found heat of 25° (C.) during the day, and cold of 8° below zero during the night. After that we need not be longer surprised that the lands comprised between the slopes south of Aurès and the chotts produce very little, however favorable in themselves they may be to vegetation. If we admit with M. Roudaire, agreeing in this point with all explorers of the chotts, that their cavities have at one time formed salt lakes, dried up gradually during the historic period, we shall obtain an explanation of the changes in the production of the soil of the province of Constantine, and of Tunis since the epoch of Roman domination, when the province of Africa was much more populous and much more fertile than at present.

M. Roudaire has sought to find results of observations from which he might conclude what would be the depth of the bed of water evaporated after the creation of the inland sea. He has found this information in the experiments made at the Bitter Lakes traversed by the Suez Canal. At the time of the filling-up of the Bitter Lakes, a waste-weir was constructed intended to regulate the introduction of the water of the Mediterranean. From July 7 to 14 the weir was wrought with only a small number of sluices raised, and the level of the lakes remained stationary. The introduction had been regulated to about 3,540,942 cubic metres, or, in round numbers, 4,000,000, cubic metres per day. This figure, then, gives the quantity of water absorbed by evaporation which, according to the extent of surface, produced a lowering of the level of from ·003 m. to ·0035 m. during twenty-four hours, and that in the hottest month of the year. All the observations made since that time have given essentially the same results, and we must admit, with the engineers of the Suez Company, a general mean of ·003 m. per day, or 1 m. per year. M. Roudaire has added, as a conclusion to be drawn from this bearing on his project :—"The basin of the chotts and the Isthmus of Suez being situated nearly under the same latitude, and possessing a climate absolutely analogous, we must admit that the evaporation which will be produced on the inland sea will be the same as that which has been observed on the Bitter Lakes. The figure ·003 m. is the general mean of the year. The observations which we have made in the chotts with Piche's evaporometer have proved to us that this figure is at least doubled during the sirocco."

Not only would the vapor of water thus diffused through the air serve as a reservoir for the heat emanating from the earth or the sun, but it would have still another mode of action for effecting climatic modifications. The air and its vapor brought into contact with the elevated and therefore cool parts, the Aurès mountains, and other mountains of Algeria, would have their temperature lowered on account of that cause, and the effect would be increased by the radiation of the vapor of water into space : for that radiation would operate almost without check at a height where the air from above, and therefore less dense, is cold and dry. Under the influence of this double cause the moisture would be condensed into rain or snow, and would serve to feed the watercourses which would permanently flow in the beds at present dry during a great part of the year. We should see issuing from the ground, from the same cause, sources which do not now exist. The moisture, discharging itself along the lines of watercourses, would extend its influence on the two slopes of the mountains to countries at a distance from the chotts. We can perceive by calculations the volume and the weight of the masses of water set in motion by evaporation, that these considerations are not chimerical. The 13,230 square kilometres give 39,690,000,000 kilogrammes of water per twenty-four hours, raised by evaporation, *i. e.*, 39,690,000 cubic metres. It will be seen that there is here something to form sources and feed streams or rivers. M. Roudaire has calculated that the quantity of vapor diffused in air whose barometric pressure is ·760 m., and the temperature 12°C., would cover the surface of Tunis and Algeria with a layer of half-saturated air, 24 metres in height. Let us remark that this calculation includes only the quantity of vapor formed during twenty-four hours. The south wind, known as the *sirocco*, at present so destructive because it is exceedingly dry, would produce on the surface of the lakes an evaporation much greater than that mean, and would, moreover, lose many of its hurtful effects. In fact, this same wind, which destroys the vegetation of Algeria, has a fertilizing influence on the territory of France, because of the moisture with which it becomes charged in crossing the Mediterranean.

Advantages so considerable, which would result from the introduction of the water of the sea into the chotts, explain and justify the perseverance with which M. Roudaire has pursued the idea without allowing himself to be arrested by any of the difficulties which have presented themselves. The greatest of the difficulties, M. Favé thinks, proceeds from the fact that the Chott El-Djerid, the nearest to the Gulf of Gabès, has not, like the others, the bottom of its basin below, but above, the level of the sea. The surface of the ground is undulating ; it rises to 20 metres, or even more, at certain points, and descends to zero at other points. M. Roudaire has estimated, somewhat vaguely, that the mean height of the bottom may be about 6 metres above sea-level. Notwithstanding this obstacle, M. Roudaire does not renounce the hope of being able to make the water of the sea reach the Chott El-Djerid in order to turn it afterwards into the other two chotts. He believes he has found a support for this in the nature of the bottom, or, to speak more exactly, in the existence of a water-bearing bed situated at a small depth below the ground.

The Commission, of which M. Favé is the mouthpiece, without pronouncing definitely on the project of M. Roudaire, sufficient data for this not being forthcoming, strongly recommend that active steps be taken to obtain more accurate measurements and other data. The facts which he has adduced they think sufficient to justify serious attention being paid to his proposal, and recommend that the thanks of the Academy be accorded to M. Roudaire for his valuable labors. To these recommendations the Academy agreed.

We should state, however, that MM. Dumas and Daubrée, members of the Commission, are not able to give their entire consent to the recommendation of M. Favé's report. They think that the obstacles to the accomplishment of the scheme are much more serious than have been estimated, and regard the industrial and climatic results anticipated as, to a considerable extent, hypothetical. M. de Lesseps, however, gives his entire concurrence to the scheme of M. Roudaire, and believes in its practicability and the favorable results that would follow its realization.—*Nature*, xvi, 253.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

SECOND PART —II.

THE STEPHENSON LINK MOTION—CONTINUED.

The Theory.—The described link motion consists of a number of oscillating and reciprocating parts, and the exact law of the movement which the link in its several grades of gearing transmits to the slide valve is extraordinarily complicated. Our theoretical investigation will therefore be based upon a series of assumptions similar to those we made when considering the common slide valve. We shall thus disregard the effect of the oscillation or obliquity of the connecting rod and of the eccentric rods, and, besides, assume that every point of the link were moving in a right horizontal line, or, in other words, we shall overlook the vertical vibration of any part of the link motion. A subsequent chapter will then treat the modification that our theoretical result suffers from these neglected influences, and show a method for finding the means to make these influences compensate each other.

The mentioned assumptions would imply a distortion of the link during its movement, and to keep these distortions within as small a margin as possible, we shall study the movement of the link while in its mid-gear, when the link-block will be operated by the centre of the link. It can then be demonstrated that the movemcnt of any point of the link can be considered as though it were produced by a separate eccentric, and it remains now for us to find the position of this imaginary eccentric.

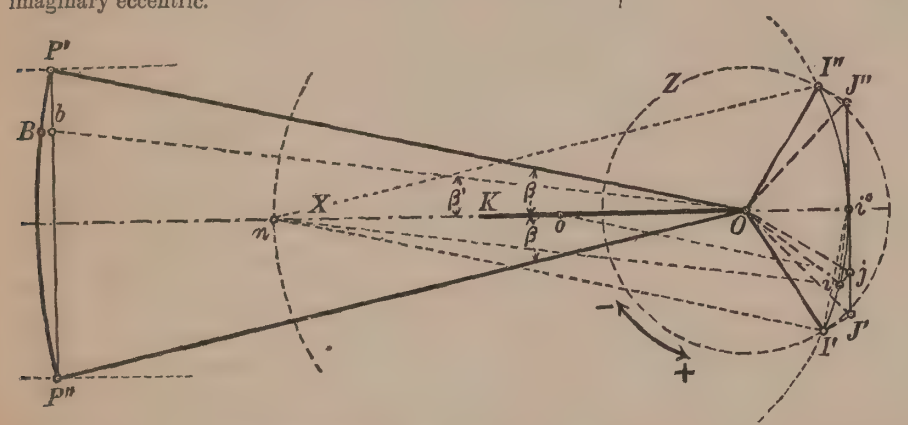

Fig. 29.

Suppose I' and I'' (Fig. 29) to represent the two eccentrics of a link motion, the link $P'\,P''$ of which is shown in its neutral position, obtained by transferring the ends of the eccentric rods to the centre O of the crank shaft. Since we assume that all points of the link, and hence also the pins P' and P'', were moving in horizontal lines, we should first understand the movement of the latter. Let us consider for this purpose the forward eccentric separately, in Fig. 30.

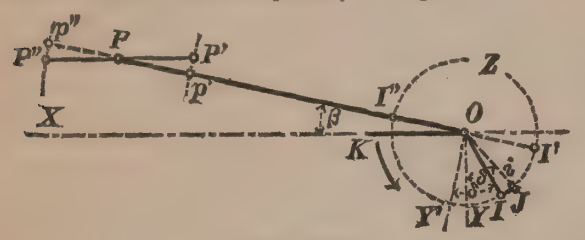

Fig. 30.

If the end P of the eccentric rod in this case were moving in the line $p'\,p''$, the angular advance of the eccentric I for this movement would be the angle $Y'OI$, OY' being at right angles to OP. If it would be desired to produce the same movement on the horizontal centre line (by a horizontal eccentric rod), the proper position of the eccentric would then be found at i by making its angle of advance $YOi = Y'OI$. However, the movement of the pin P is actually in the line $P'\,P''$, and, therefore, when the eccentric I is at I' or I'' the end P will not be at p' or p'', but at P' or P'', respectively. The arcs $p'\,P'$ and $p''\,P''$ are very short in proportion to their radius, and may therefore be considered, approximately, to be right lines, forming right angles with $O\,P$. Now it will be observed that the travel $P'\,P''$ slightly exceeds $p'\,p''$, and hence also the diameter of the eccentric path Z, and to produce a movement, on the horizontal line $O\,X$, equivalent to that of the pin P on the line $P'\,P''$, we would have to increase the throw of the eccentric from i to J, by making $O\,J = P\,P'$. The point J can therefore be regarded the "ideal eccentric" for the movement of P.

A glance will now show that the angle $I\,O\,J$ is equal to the angle $P\,O\,X = \beta$, in other words, to obtain the ideal eccentric J, *the eccentric I would have to be moved on the crankshaft, through the same angle and in the same direction as the eccentric rod P would have to be moved to bring it in a horizontal position.* Besides, the triangle $O\,I\,J$ is equal to the triangle $P\,p'\,P'$, whence it appears that *the line $J\,I$ is at right angles with $O\,I$.*

Applying these results to Fig. 29, we find the points J' and J'' representing the ideal eccentrics for the movements of the extreme points P' and P'' of the link, by making $I'\,O\,J' = I''\,O\,J'' = \beta$, and besides $I'\,J'$ and $I''\,J''$ at right angles to $O\,I'$ and $O\,I''$, respectively.

We are now prepared to study the movement of any point of the chord $P'\,P''$ of the link, say of b. It can be asserted that, by dividing the line $J'\,J''$ in the same proportion in which the point b divides the chord $P'\,P''$, a point j is obtained that can be considered the ideal eccentric of the movement of the point b. (The point b being on the forward end, P', of the link, the point j is on the side of the forward eccentric J' of the line $J'\,J''$.) To prove this proposition we show, in Fig. 31, the crank $O\,K$ rotated through the angle α, and also the several real and ideal eccentrics, in their corresponding position. The link will then assume the position $P'\,P''$,

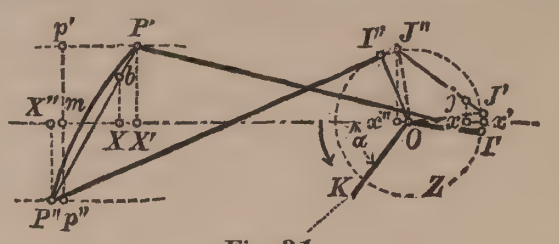

Fig. 31.

and $p'\,p''$ shows its neutral position, intersecting the line $O\,X$ in the point m. We then project, upon the horizontal centre line, the points P', P'' and b and the ideal eccentrics $J'\,J''$ and j, obtaining the points X', X'', X, x', x'' and x.

According to the foregoing demonstrations, the position of the points x' and x'' in relation to O will correspond with that of the points X' and X'' in relation to m, and since the position of x in relation to x' and x'' will correspond with the position of X in relation to X' and X'', on account of the proportional division of the lines $J'\,J''$ and $P'\,P''$, it is evident that the distances $O\,x$ and $m\,X$ are equal; or the horizontal movement of the point j equals the horizontal movement of the point b, and our assertion is demonstrated.

It must, however, be remembered that an eccentric at j can produce a movement as said only through a horizontal eccentric rod, and if it was desired to produce the movement of the point b by a direct connection, it would be necessary that the eccentric rod should have an inclination $= \beta'$ (see Fig. 29). The case would then come under the same head as that considered before (see Fig. 30), and knowing the ideal eccentric j (Fig. 29) we can find the desired eccentric i by making the angle $j\,O\,i = \beta'$ and $j\,i$ at right angles to $O\,i$. Thus it is demonstrated that if an eccentric, at i, were added to the two eccentrics I' and I'', and were connected by an eccentric rod with the point b of the link, these three eccentrics would operate in perfect harmony; but it should never be lost sight of, that this entire demonstration is based on our initial assumptions and is therefore only approximately correct.

A lowering of the link that brings the point b in the centre line $O\,X$ will also bring the imaginary eccentric i in a direct line of action, and the link-block will move as if it was moved by this eccentric; the point i is therefore the ideal eccentric of the movement of the valve for this grade of the link.

The movement of other points of the link can be examined in the same way, and the result will be a series of "ideal eccentrics," like i, forming a continuous curve $I'\,i\,I'$ (Fig. 29) which may be termed "*locus* of ideal eccentrics," or briefly *locus*, and it is demonstrable that this curve is a circular arc, tangent to the line $J'\,J''$.

Directing our attention to the quadrangle $O\,i^{\circ}\,j\,i$, we will notice that the two angles at i° and at i are right angles, and therefore, if we draw the line $i\,i_{\circ}$, the angles $i\,i^{\circ}\,j$ and $i\,O\,j$ will be equal, according to a well known geometrical proposition. This shows that the line $i\,i_{\circ}$ forms right angles with the line $O\,b$, since we made the angle $i\,O\,j = \beta'$, which is the angle through which the link and the eccentric rods have to be lowered (starting from the mid-gear) to bring the point b and hence also the ideal eccentric i in direct action. The same thing is true for every other ideal eccentric, and also for the real eccentrics I' and I''.

Referring to this fact, we can find the centre of the "*locus*" by drawing a line through I', perpendicularly to $O\,P'$, that intersects the centre line $O\,X$ in i°, and by subsequently bisecting the line $I'\,i^{\circ}$ by a line parallel to $O\,P'$, that intersects the line $O\,X$ in the required centre o of the arc $I'\,i^{\circ}\,I'$.

If now the circle of the *locus* is extended to its second intersection at n, with the line $O\,X$, and we draw the lines $n\,I'$ and $n\,i$, it can easily be proven that the horizontal inclination of these lines will equal the angles β and β' respectively; hence $n\,I'$ is parallel to $P'\,O$ and $n\,i$ parallel to $b\,O$. This fact can very conveniently be used for locating on the *locus* the ideal eccentric for any point of the link.

In the foregoing we investigated the movement of a link with open rods. If, however, the rods are crossed, the inclination of the eccentric rods will have the effect of diminishing, not increasing, the angular advance of the eccentrics. The ideal eccentrics for the movement of the ends P' and P'' of the eccentric rods (Fig. 32) will be found to be located at

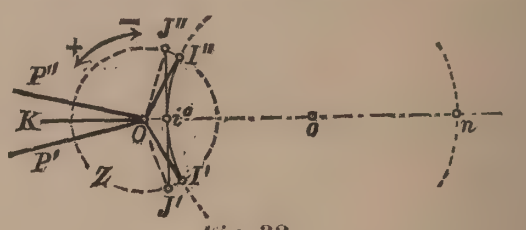

Fig. 32.

J' and J'', in accordance with the rule found in relation to Fig. 30. The *locus* of ideal eccentrics can now be determined as before, and will again be found to be a circular arc, but its convex side will be turned towards the centre O of the crank-shaft. The rules for finding the centre of this arc and for locating the ideal eccentric for any point of the link, are the same for crossed as for open rods.

If the link has the form shown in Fig. 26 it cannot be lowered or raised far enough to bring the pins P' and P'' in the centre line, and the extreme positions to which the link can be lowered or raised were heretofore regarded intermediate grades. Only a portion of the link is available, and we can therefore use only a portion of the *locus* of eccentrics, as shown in Fig. 33.

Fig. 33.

For convenience, the rule for constructing the *locus* of ideal eccentrics shall here be recapitulated in a condensed form.

Make a skeleton drawing (Fig. 29) showing the position of the eccentrics I' and I'', relatively to the centre line of the link motion $O\,X$, while the crank is on one of its dead centres. Then draw the link $P'\,P''$ in mid-gear, in its neutral position (which may be done to reduced scale) and a line through the forward eccentric I', at right angles with the forward eccentric rod $O\,P'$, the line $O\,X$ in i° meeting. Bisect the line $I'\,i^{\circ}$ by a line parallel to $O\,P'$ and obtain the centre o of the *locus*.* Sweep the *locus* $I'\,i^{\circ}\,I'$ and mark at the same time the point n of the same circle. The ideal eccentric of any point of the link, say of b, is found by drawing through n a line parallel to the line $b\,O$, which intersects the *locus* in the sought point i.

(To be continued.)

Stopping up the Regenerators in the Siemens Furnace.—This is caused by sodium chloride, which is usually present in minute quantities in the sand bottoms of the reheating furnaces and in the water used to solidify the slag bottoms of the puddling furnaces, forming, with the iron on the hearth, iron chlorides, which are carried by the escaping gases into the reheating chambers, where they are decomposed into ferric oxide and hydrochloric acid by the aqueous vapor which is always present. The ferric oxide is deposited as a brick red powder. The ammonia from the fuel comes in contact with the acid when the valves are reversed, forming ammonium chloride, which the iron on the hearth decomposes. In this manner small quantities of sodium chloride do considerable harm. The ammonia should be washed out of the gas by passing it through a coke tower.—*Zeitschrift des Berg- und Huettenmœnnischen Vereines für Stiermark und Kärnten—per Metal. Review*, i, 68.

* If the eccentric rods are crossed, the points P' and P'' will exchange their places, and the centre o of the *locus* will accordingly be found on the other side of the crank-shaft.

PROGRESS IN SCIENCE AND THE ARTS.

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ENGINEERING—CIVIL, MECHANICAL &c.

A Remarkable Loop.—An instance of engineering skill is seen near Yuma, on the Southern Pacific Railroad, known as the "Loop." In laying out the line the engineers found great difficulty in reaching the summit without exceeding the grade; to which they were restricted. They found they could only accomplish it by winding a long distance around and making several bends in the track. Col. Grey found a way out of the difficulty by making the road to loop or circle upon itself, the first attempt of the kind in railway engineering. The road passes at a certain point through a short tunnel, and bends greatly to the left. Rising steadily and as steadily bending to the left, the track makes a loop around the mountain and passes directly above the tunnel.

The Burleigh Tunnel.—This tunnel now penetrates into Sherman mountain a distance of 2,200 feet, and is still being driven in as fast as the Burleigh air compressors and high explosives, guided by skill and experience, can accomplish the work, which is at the rate of about two feet per day. Messrs. Loring, Nickerson and Green are the contractors, and they are progressing satisfactorily, though not as fast as they have done the past four months, on account of the increasing hardness of the rock. The holes are drilled with double-bitted drills from six to eight feet deep; the boring machinery is run back on the track about 200 feet and the blasts exploded. The gases resulting from the combustion of the giant powder are highly noxious, but the deleterious effects are more likely to be felt a distance of 200 feet or more from the heading of the tunnel than right up at the breast where air is supplied by the compressors.

Twenty lodes have already been intersected by this colossal prospecting enterprise, two of which have been worked extensively, and immense quantities of ore have been taken out. The principal lode, as yet discovered, is the New Era, which generally carries a body of solid ore from two to three, and in some places as much as four feet in thickness. This, however, is of low grade, but owing to the increasing facilities for transportation and treatment of this class of ore, it cannot fail to prove highly remunerative; indeed, a vein half the size of this would be a bonanza in any other place than Clear Creek county, where silver is the ore that is most particularly sought after and devoutly wished for; but the time is not far distant when many of the mines in this county that have not been touched for years will be actively worked for the lead they contain and will yield handsome profits to their owners.

The New Era was cut 920 feet from the commencement of the tunnel, and has been opened out by drifting 250 feet each way. Fifty feet west from the tunnel a winze 40 feet deep has recently been sunk, and a drift is being run west from a point in the shaft 35 feet below the tunnel level. This will open up a slope carrying a vein of galena of incredible size, and undoubted permanency, the upper edge of which forms the floor of the drift above. This lode is fourteen feet in width, dips to the north at an angle of 35°, and its course is nearly east and west.

The Rider lode is 1,700 feet from the tunnel's entrance, and has been explored some, though nothing like the New Era. We did not examine this vein, but Mr. Loring, the foreman, to whom we are indebted for much valuable information and a ride on the car from the breast to the mouth of the tunnel, informs us that a drift has been run east on the lode 40 feet, and another one west 80 feet. – *Colorado Miner.*

Shooting under Water.—Experiments have recently been made by General Von Uchatius to ascertain the effect produced by firing with a rifle wholly under water. At each shot there was a dull sound which could not be heard more than the distance of 50 paces, and bubbles of smoke rose above the surface. At the distance of 1½ meters no impression whatever was produced on the target: at 1¼ meters the ball entered; at 1 meter the ball passed through. It was found that no greater effect was produced by corking up the barrel at its mouth to keep out the water.

A Straw Burner.—At the recent show at Liverpool a straw-burning engine on Kotzo's system was exhibited. The engine has a deep firebox below the ordinary fire-floor, which is provided with a conical mouthpiece, through which the straw is fed by hand. The engine may be worked with coal, as a grate is fixed above this mouthpiece. The ratio of grate to heating surface in an eight-horse power engine is 1 to 37.6; the tubes are 2½ inches in diameter; 4.2 square feet of grate; firebox surface is 26 square feet; tube surface 132; making 158 square feet of heating surface in all. From several trials the average evaporation of water was 1.6 lbs. to 1 lb. of straw.

Steel Cars.—The Grand Trunk Railway Directorate, of Canada, proposes to introduce steel cars in which to carry grain. They are to be shorter than the present cars and as much stronger as steel is than wood, which will permit of the grain being loaded higher than at present. The new cars are to weigh 6 tons instead of 10 tons as now, and carry 18 tons instead of 10. Cars of the new model are being experimented with.—*Iron*, xi, 167.

Heating a City by Steam.—We sometime ago referred to the fact that efforts were making to furnish steam to the people of a whole village or section of a city, as gas has for some time been done, also that it was proposed to transmit power by steam, compressed air or hydraulic pressure. We now have a statement of the initial attempt at warming a village by steam at Lockport, N. Y. The cost is thought to be but little more than half the cost of stoves, although the great heat for kitchen apparatus may be less easy to furnish. From the steam boilers the supply of heat is forced through pipes laid under ground to the buildings which are to be warmed. The main pipe, constructed of iron, is in size about five inches in diameter. Around the pipe is wound hair cloth one-half to three-quarters of an inch in thickness, and over this is wrapped heavy Manilla paper. Thus prepared, the pipes are laid in hollow logs, which are covered with zinc.—*The Age of Steel*, ii, 16.

Steel Vessels for Central Africa.—Colonel Gordon, Governor-General of Upper Egypt, has entered into a contract with Messrs. Yarrow & Co., of Poplar, for the construction of four very light draft steel steamers, for use on Lake Albert Nyanza, and for opening up the navigation of the rivers of Central Africa. These steamers will be carried on land on the backs of negroes, and consequently the builders have to subdivide the packages in such a manner that none shall exceed 200 lbs. in weight. It is estimated that no less than 4000 men will be employed for the porterage of these vessels. —*Iron*, x, 236.

Telegraphs in China.—The first telegraph line in China is now in operation. It is six miles in length and has been erected by Li Hung Chang, Viceroy of Chili, from his official residence to the Fretain Arsenal. There has been no attempt at interference by the native populace, as in the case of the telegraphs projected by foreigners. Several lines are contemplated in Formosa by the Governor of that island.—*Iron*, x, 236.

MINING, METALLURGY AND MINERALOGY.

Minerals in the Transvaal.—The Transvaal, the State recently annexed by the Britishers, is a country larger in area than France, and more or less settled by a thinly-scattered community of farmers. It has two townships of some importance from a colonial point of view, Potschefstroom and Pretoria, besides smaller villages. It has splendid pastoral resources, fine agricultural capabilities, varied though undeveloped mineral wealth, in gold, lead, coal, cobalt, iron, and copper, and a climate that can scarcely be surpassed. The accession of so valuable a territory forms an event of very high imperial importance —*The Engineering and Mining Journal*, xxiv, 190.

Cinder in Puddled Iron.—To show the amount of finely divided cinder in the composition of puddled iron, M. Chatelier heated a piece of this metal under the action of a stream of chlorine gas, so as to completely vaporize it. There remained a residuum of whitish green color and very light weight, having the general form of the piece of iron experimented upon. This was found to be composed wholly of finely divided cinder.—*Metall. Review*, i, 58.

Nails from Old Rails.—General W. H. Powell, of Belleville, Ill., has patented a process for utilizing old rails in the manufacture of nails which has been very successful at his mills in the above-named place. The great difficulty in working old rails has been from imperfect welds, the nail having a tendency to split. In making his pile of rails General Powell fills the spaces between the rails with scrap iron, generally nail scrap, thereby giving a perfect weld. No puddled iron is used, and the nails do not split in cutting more than those made from all pig iron. Nails are also made from old rails at Wheeling, W. Va., by a somewhat different process. The rails are cut and piled for the heating furnaces like so much muck bar, and by the use of a flux in the heating process are welded and made as malleable, ductile and close textured in the sheet rolls as so much piled muck. As boiling is unnecessary, there is a considerable economy in using old rails, and the product is said to be of satisfactory quality.—*Metall. Review*, i, 96.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Astruthin is a new crystalline body obtained by E. V. Gorup-Besanez from the roots of the masterwort. It is odorless, almost tasteless, and easily reduced to a white powder. Astruthin does not contain nitrogen. The mean of eight analyses gives carbon 77.07 per cent. and hydrogen 7.98 per cent.—*Liebig's Annalen.*

Chlorine Compounds in the Blast Furnace.—The presence of chlorides of potassium, calcium, iron, etc., and hydrochloric acid in the gases from blast furnaces, had been observed in several cases. The author traced them to the coke used, and from water that had been used to wash 36 kilos. of coke he obtained 43.54 grms. chloride of sodium and 1.38 grms. chloride of potassium. A furnace using such coke would receive an amount of hydrochloric acid corresponding to about two carboys of the acid of commerce.—*Zeitschrift des Vereines Deutscher Ingenieure—per Metall. Review*, i, 86.

Adulteration of Aniline Colors.—The general adoption of aniline colors, even in small industries, has naturally offered a wide field for fraud. The more evident adulterations, especially the so-called "bronze waste," the purchaser can easily detect, for the bronze filings are precipitated in the ordinary dissolvent of aniline colors. Lately, however, a very ingenious adulteration of fuchsine has been put in the trade—the *diamond fuchsine*—which is sold at a very low price, but which surprises purchasers by the feebleness of its action compared to ordinary samples. The product in question is difficult to be distinguished from the genuine. It burns without leaving any very perceptible residuum, and is probably soluble in the ordinary dissolvents. But when it is heated it is easy to detect an abnormal odor, and we can see more readily than when we try to dissolve it in concentrated alcohol that there remains a crystalline portion of a weak red color, which does not dissolve on the first treatment.

An attentive examination of these crystals will show them to be nothing more than the ordinary ones of raw sugar, such as are obtained by the simple boiling of syrups and in refining.

It is, however, more difficult than might be supposed to separate the fuchsine from the sugar so as to ascertain quantitatively the latter. The following is found to be the best method: A portion of fuchsine is taken by weight and dissolved in warm water; to the solution a solution of picric acid is added, and the greater part of the rose-aniline is precipitated in a state of picrate. The liquor, which is filtered and settled by the excess of picric acid, is of a yellow color, and is precipitated by the acetate of lead; the solution, heated to 110 deg. C. is then filtered and submitted to polarization for the sugar.

It has been ascertained that some of these fuchsines contained 15 per cent. of sugar, one even 24.2 per cent., and a third as high as 82.13 per cent.

The method of manufacturing these preparations is probably by watering crystallized sugar with a solution saturated with fuchsine in very concentrated alcohol. This is the only way of explaining that the small isolated crystals have the same magnificent metallic green as the fuchsine crystals. A very easy way of detecting the false preparation is by spreading it on a sheet of white paper and leaving it in a well lighted spot; or better, where the sun's rays beat directly and examine with magnifying glass. Pure fuchsine presents only the well known awl-shaped crystals or their fragments, which even under the light of the sun appear red only on the borders. It is different with the adulterated fuchsine; in addition to the characteristic crystals of the fuchsine a smaller or greater quantity of thinner crystals will be perceived, most of them colored a garnet red, or amethyst red, or, as found in a sample containing 83.13 per cent. of sugar, red crystals only. If a piece is taken on the point of a knife and burnt, the odor of burnt sugar is easily perceived.—*Teinturier Pratique—per Paper Trade Journal.*

Phosphide of Copper.—M. Lidot has presented to the Paris Academy of Sciences a flask containing phosphide of copper so perfectly crystallized that a crystallographer would possibly be able to determine its form. M. Lidot presumes that this substance enters into the composition of certain bronzes, which thus acquire a remarkable sonority, besides becoming very hard and very brittle.

Imitation Leather.—The latest thing in the shoe and leather trade is "imitation leather," to take the place of skivers, sheepskins, roans, etc., as lining for shoes, carpet-bags and lambrequins. The article is composed of heavy cotton cloth, made especially for the purpose, and covered with a series of coats of chemical substances which give it the appearance of leather; and so much does it resemble the ordinary leather lining used for the same purpose that very few, even old shoe manufacturers, have been able to detect the difference between the real article and the imitation, while it is asserted that the latter possesses several points of superiority over the former from the fact that it is much more durable, can be worked up in an easier and more economical manner, is considerably cheaper, and can be used for all purposes of lining, except in shoes made from leather containing large quantities of oil. Its color, also, (the article is manufactured in every imaginable color that can be desired) is said to be firmer and more uniform than that of kid or sheep linings, and is never affected by heat, cold or moisture.

"Imitation leather" was only introduced three or four months ago, and until the present time the manufacturers have made no especial attempts to advertise it or push it into notoriety, but it is reported to have given great satisfaction wherever it has been used, and attained considerable celebrity upon its own merits in different parts of the country, and the demand for it has now become so large that the manufacturers have been obliged to establish a special factory for its production, with facilities for manufacturing upon a very extensive scale.—*The Manufacturer & Builder*, ix, 203.

Another Electric Candle.—According to the *Telegraphic Journal*, M. Plante has called attention in the French Academy to the bright light obtained when an electrode of one of his secondary batteries (a powerful one) is applied to a glass tube or wall of a glass vessel containing a saline solution. With the positive pole a stronger force is required; but the light is more silent than with the negative, which produces some crackling. When the light appears an abundant white vapor is given off, having a slight alkaline reaction. The glass is strongly attacked and devitrified. It might be thought that the brightness was due to lime combined in the silicon; but in the spectrum there are no appreciable lines, except some traces of that of sodium; whereas a piece of lime spar, under the same conditions, gives distinctly the lines of calcium along with a continuous spectrum. The lines of silicium do not appear, being weak, and the spectrum being intensely luminous, just as the carbon lines are not perceptible in the spectrum from the voltaic arc. The silicic origin of the light is further proved by the fact that it is obtained likewise on contact of the electrode with pure silicon in the state of crystal of hyaline quartz. M. Plante proposes to distinguish this kind of light as the *electro-silicic* light.—*The Manufacturer and Builder*, ix, 205.

The Antiseptic Properties of Boracic Acid.—The antiseptic properties of boracic acid for the preservation of organic matter have again been tested by G. Polli of Mailand, partly by personal observation and partly in large hospitals. The same experiments were made with the alkaline sulphides and phenole. He found that for the preservation of beer, milk, eggs, urine, and defibrinated blood, boracic acid was much more effective than the sulphides and equally so with phenol. Also as a disinfectant of wounds and a deodorizer boracic acid can be advantageously employed.

Method for Gelatinizing Carbonbisulphide, Petroleum, Benzin, etc.—Mercier has observed that fixed oils, more particularly the drying oils, when mixed with a small quantity of protochloride of sulphur, form a solid transparent mass, having nearly the elasticity of caoutchouc. If at the moment of mixing, a volatile liquid, soluble in the oil, be added, the solid mass will retain that liquid. Less than 10 per cent. of the sulphur chloride should be used to obtain a glue-like non-pulverizable mass, which will retain 70 per cent. of carbonbisulphide; but by increasing the chloride the mass will assume the aspect of horn and be so friable as to be easily reduced to powder by rubbing between the fingers, while at the same time the largest portion of the volatile liquid is given off. Boiled linseed oil is best adapted for these purposes.—*Rép. de Phar,*, May 15, p. 294.

Littoral Changes at Port Said.—It is estimated that the coast at the mouth of the Suez Canal, at Port Said, is advancing outward at the rapid rate of about 50 yards per annum, and that the necessity for extensive dredging will be greater year by year. Not less than 937,000 cubic yards of deposit had to be removed in 1875, while the dredging of 161,000 cubic yards sufficed in 1871. The British Government has ordered a new survey of the coast between Port Said and the Damietta mouth of the Nile, in order to ascertain the actual condition and the rate of increase of the sand-banks, and to see if any plan besides dredging can be adopted to check the growth of the obstruction.—*Iron Age*, August 30th, 1877.

Mixtures for Tempering Small Steel Articles.—By mixing 4·75 quarts sperm oil with 4 pounds tallow and 1-4 pound wax, we obtain an excellent material for tempering small steel articles of any shape. By adding 1 pound of resin the mixture will also serve to temper larger articles. The addition of the resin must be done with great care, since if too much is used the articles tempered will become too hard and brittle. After some months' use this mixture loses its value, and when replaced, if the same vessel is used, care should be taken to thoroughly cleanse it of all the old mixture. Another mixture which has been found useful in practice, is composed as follows: 95 quarts spermaceti oil, 20 pounds tallow, 4·75 quarts of oil from beef fat, 1 pound pitch, and 3 pounds resin. The pitch and resin are melted together, and when thoroughly incorporated the other three ingredients are successively added and the mass heated in an iron vessel until all the water has been driven off by evaporation. So much of the mass as is not for immediate use should be kept in hermetically sealed vessels. The use of these mixtures in tempering is as follows: Scythe blades, for example, are heated to the proper temperature and thrust into the oil bath, where they remain until nearly cold. They are then taken out and lightly rubbed with a piece of leather, leaving a thin film of the mixture upon the blades. They are then passed over a light coke fire and heated until the oil takes fire and burns. When hardness is required, only a part of the oil should be burned off. After this the blades are heated to a straw color, which disappears upon immersion in a bath of hydrochloric acid and a subseqnent washing in clean water.—*Annales du Génie Civil—per Metall. Review*, i, 100.

Apropos of the Electric Light, they have fitted up twelve electric lamps at the Lyons railway station, and twelve more will be added forthwith. These twenty-four lamps will be fed bv a single machine. It is believed that twenty-two horse power will yield a light equivalent to 2,400 gas lamps, each lamp burning 100 litres of gas per hour. The electric light apparatus with which H. M. S. *Alexandra* has been provided, and which is designed for the detection of torpedo boats, has been fitted at a cost of £1000. The electric lamp is fixed on the foremast.—*The Telegraphic Journal*, v, 209.

Proportion of Carbonic Acid in the Atmosphere.—Prof. Franz Farsky.—As the mean of 295 determinations the author gives the proportion of carbonic acid as 3·43 vols. in 10,000 of air. This figure is lower than those found by De Saussure and J. Boussingault, but higher than the results obtained by Schultze, Henneberg, Fittbogen, and Hässelbarth. The most numerous fluctuations were observed in November, December, February, March, and April, and the fewest in October. All meteorological conditions were registered along with each observation.—*Biedermann's Central Blatt, per Chemical News.*

A New Discovery in Magnetism.—In a recent number of *Comptes Rendus*, of the Paris Academy, M. Donati Thomasi publishes the fact that when a current of steam is sent, under pressure of from five to six atmospheres through a copper tube of from two to three mm. diameter, wound spirally around an iron cylinder, the latter becomes so strongly magnetic that an iron needle placed some centimetres away from it is energetically attracted, and remains magnetised during the whole time the steam current passes through the tube.—*Telegraphic Journal*, v, 210.

Deodorizing Petroleum.—M. Mason, of Lyons, has succeeded in removing the disagreeable odor of petroleum by the following process:—Into a vessel containing 225 lbs. of petroleum, are separately introduced by means of a funnel, 2 oz. each of sulphuric and nitric acid, and 11·1 lbs. of stronger alcohol are carefully poured upon the surface of the petroleum. The alcohol gradually sinks to the bottom, and when coming in contact with the acids heat is developed, and some effervescence takes place, but not in proportion to the quantity of the liquids. Ethereal products of a very agreeable odor are formed, and the substances thus treated acquire an analogous odor, at the same time becoming yellowish in color. The operation lasts about an hour, after which the liquids are thoroughly agitated for some minutes with water, and after resting for eight or ten hours the purified petroleum is drawn off. The lower stratum, which is a mixture of the acids, water, and alcohol, may be used for deodorizing the heavy oils of petroleum, by agitating them well for twenty minutes, and after twelve hours, washing the oil twice with milk of lime, to remove the free acids. It will then have the same but a weaker odor, as the light petroleum first treated, and answers well for lubricating purposes. Petroleum thus purified may be used in pharmacy for many purposes. All the tinctures for external use may be prepared with it, like the tincture of arnica, alkanet, and camphor. It may be used for dissolving ether and chloroform like alcohol, and, combined with fats or glycerin, promises to be of great utility in the treatment of skin diseases, etc. The alcohol used in pharmacy might be replaced by this purified petroleum.—*Engineer*, xliv, 151.

Pressed Bricks are made from blast furnace slag and the following materials in Germany. To the powdered slag 42 per cent. silicic acid, 37 per cent. gypsum, 10 per cent. clay, 5 per cent. oxide of iron, 3 per cent. magnesium, 1½ per cent. sulphur, and various other materials mixed with lime are added. The mixture is given the common brick form in a steam press, and after drying in the air for three months are ready for use. The daily production of the presses are about 8000 bricks.—*Engineer*, xliv, 151.

MISCELLANEOUS.

Demonstrating the Existence of Sounds Inaudible to the Human Ear.—It is well known that certain flames, especially those made by a mixture of gas and air burning over a wire gauze, are sensitive to certain sounds—that means, vibrate, change their shape, bifurcate, become shorter or longer, etc. The journal, *Nature*, reports some curious effects of small whistles invented by Galton, which can be made to yield such high sounds as to be beyond the limit of hearing, wherefore the real existence of their high sounds has been doubted by some. Mr. Barrett suggested to try these whistles on sensitive flames. Such a flame was arranged, just two feet high when undisturbed, but shrinking down to seven inches under the influence of the feeblest hiss or the click of two coins. Adjusting the Galton whistle so as to yield its lowest note, little or no effect was produced on the flame; a shrill dog-whistle produced a slight forking of the flame, but that was all. Raising the pitch of the whistle, the flame became more and more agitated, until, when Mr. Barrett had nearly reached the limit of audibility of his left ear, and had gone quite beyond the limit of his right ear, the flame was still more violently affected. Raising the pitch still higher, until he quite ceased to hear any sound, and until several friends could likewise detect no sound, even when close to the whistle, all were astonished to observe the profound effect produced upon the flame. At every inaudible puff of the whistle the flame fell fully 16 inches, and burst forth in its characteristic roar, at the same time losing its luminosity, and when viewed in a moving mirror, presented a multitude of ragged images, with torn sides and flickering tongues—indicating a state of rapid, complex, and vigorous vibration.

Nor was this effect sensibly diminished by a distance of some 20 feet from the flame. Placing the flame at one end of a large lecture-room, and blowing the whistle at the farthest point away, a distance at least of 50 feet, and more than 30 feet above the flame, still the effect produced was very pronounced. There can hardly be a more striking experiment. A single silent and gentle puff of air sent from the lips through the whistle, nothing whatever to be heard, and yet 50 feet away an effect produced that might readily be seen by thousands of people.

The extreme smallness of the amount of motion actually concerned in producing this great change in the aspect of the flame is evident. For the inaudible vibrations, having at their origin but a small amplitude, gave rise to a spherical air wave, which, at a radius of 50 feet - and with the vast enfeeblement due to this distance—knocked down a 2-foot flame, though the surface acted upon had an area of less than a square inch—for it is only the root of the flame that picks up the wave motion. Of course everything depends upon the delicately poised state into which the flame has previously to be brought. It then, like a resonant jar, enters into a state of vibration which appears to be synchronous with the note producing the effect. By this means it may be possible, with the aid of a mirror moving at a known speed, to determine the vibration number of these high notes, and thus with greater exactitude fix the upper limit of hearing.

The flame giving the effect here described was produced by coal-gas contained in a holder under a pressure of 10 inches of water, and issuing from a steatite jet having a circular orifice 0.04 inch in diameter.—*Manufacturer and Builder*, ix, 206.

Colossal Balloon at the Paris Exhibition.—Among the objects of interest at the Paris Exhibition of 1878, will be a monster captive balloon. It will be 16 feet higher than the Arc de Triomphe. It will be strong enough to carry an engine and its driver; it will hold 50 persons at one time, and raise them to an elevation of more than 1,600 feet. It will be made of alternate layers of silk and India-rubber, which will be joined together by more than 3½ miles of cotton. The balloon will be held captive by cables capable of resisting a strain of 10,000 kilogrs.—*Manufacturer and Builder*, ix, 197.

—The refrigerator car which is in course of construction by Gilbert, Bush & Co., Troy, New York, is nearly completed. Its first trip will be to Red River, Arkansas, with a load of nitro-glycerine.

New Applications, Inventions and Industries Wanted.—One of the most important fields for present improvement, application and invention is in the greater production and utilization of the productions of the soil. Invention in rat-traps, nail machines, wire benders, screw cutters, and a hundred thousand ways of producing iron and metal appliances at a cost next to nothing are abundant; the country has gone crazy upon patents, but largely to no great service to anybody. What is now wanted is a little practical application to an increase in the farm products and their greater utilization.

The nation wants two blades of grass to grow where there is but one, two bushels where there is but one, two hogs, two cows and calves, two sheep and two hens, chickens and turkeys, and in many instances half a dozen of all of these where but one is now found. There needs be more and better butter and cheese, and a better care of it, more and better gardening and better care of fruits and produce when raised.

There wants preserving establishments, so that corn and tomatoes, and peas and pears and peaches need not be brought from Maine and California. Discoveries of processes of des sicating vegetables for foreign markets. Immense fortunes are now making in packing fruits at Eastern points; profit is making in St. Louis, in drying eggs and packing beef for other markets, and yet eggs are abundant at 7 and 8 cents a dozen and good profit in raising poultry. Beef, pork and veal and mutton are always in demand at a profit. America ships $20,000,000 of lard to France to be made into oil and shipped here again and to other points. Not half the milk is produced there is a market for. The rugged lands of the East produce milk and condense and can to a profit, so may the West.

Germany and France put up a vegetable, pea and meat soup material, giving a dinner for two cents. We want a dozen such industries. Dried and canned corn, dried and prepared squash, pearl barley, starch vermicelli and maccaroni, and many similar products.

Corn is now made into sugar with profit, but there should be a hundred such sugar establishments. Not half the attention is given to fall and winter vegetables that there is a demand for. Beets for sugar and for stock is an industry almost entirely neglected. Flax has no place at all in this country. If our inventive minds will give their attention to this branch of industrial development for a few years and demonstrate the practicability of a garden of Eden and a good living in every plat of 10 acres they will do the country a service.—*The Age of Steel*, ii, 8.

Dried Eggs.—A large establishment has been opened in St. Louis for drying eggs. It is in full operation, and hundreds of thousands of dozens are going into its insatiable maw. The eggs are carefully "candled" by hand—that is, examined by light to ascertain whether good or not—and are then thrown into an immense receptacle, where they are broken, and by a centrifugal operation the white and yolk are separated from the shell very much as liquid honey is separated from the comb. The liquid is then dried by heat, by patent process, and the dried article is left, resembling sugar; and it is put in barrels and is ready for transportation anywhere. This dried article has been taken twice across the equator in ships, and then made into omelet, and compared with omelet made from fresh eggs in the same manner, and the best judges could not detect the difference between the two. Is this not an age of wonders? Milk made solid, cider made solid, apple butter made into bricks! What next?—*The Age of Steel*, ii, 16.

The Auction Sale of Patents by Geo. W. Keeler, on the 3d inst., was largely attended by speculators and others interested in inventions, as we are informed by Mr. Keeler.

One hundred and sixty patents were offered, out of which about 30 were passed for want of bids; the remainder were sold at prices varying from $50 to $1200.

A notable feature in connection with these sales is the fact that several patents are sometimes purchased by one person, and the question naturally suggests itself, what do these people want so many patents for, &c.? The answer is,—these purchasers are speculators, who never intend to develop a single patent that they purchase, except, perhaps, in exceptional cases, when they arrange with some manufacturing firm to develop the patent by placing the goods in the market. The most of the patents are utilized in "trades" and "exchanges" and in this way a very profitable business is done.

The next sale will take place the first week in October, and it is quite safe to assume that the prices will be much better for good practical inventions at this and succeeding sales than those realized from preceding ones, an event which will be appreciated by the owners of patents.

—At the latest moment of going to press, the compositor informs us that he needs copy to fill four lines. We think that by careful spacing he can make these two senteuces answer.

Novel Joint Stock Company.—Signor Parnetti has been engaged in analyzing the dust and *débris* of the streets of Florence and Paris. His investigation of the *débris* of the horse paths proves that the dust contains 35 per cent. of iron given by the shoes of the horses to the stones. In the dust from the causeways this eminent chemist finds from 30 to 40 per cent. of good glue. Signor Parnetti selected and treated separately the dust from the causeways of the Boulevard des Italien over a period of two months, which uniformly gave 30 per cent. of good transparent glue, it is said quite equal to Belfast. This eminent chemist is now engaged in the analysis of the dust and debris deposited by the shoe abrasions in Lombard street, Cornhill, Cheapside, and other active thoroughfares in the city, and has it in contemplation to place his discoveries at the disposal of a limited company, with the view of establishing blast furnaces on the banks of the Thames to recover the iron thus lost, and a large glue works, which it is thought will produce more glue from the wasted material than will supply all London for every purpose.—*Iron Trade Exchange—per Metal. Review*, i, 100.

The Peruvian Niter-Beds.—On the Pacific coast of South America, extending from the fourth to the fortieth degree of south latitude, about 2,400 miles along the slope of the Andes to the sea, in Bolivia, Peru, and part of Chili, there has been found a line of deposits of sodium nitrate, the "Peruvian niter." The beds are of variable thickness, covered by from one to ten yards' depth of earth and half-formed sandstone. The dry soil of the most of this rainless country is pervaded, in some degree, with this deposit. The mummied remains of the old Peruvian people are embalmed with it by the earth in which they are buried; and its crystals glisten on those ghastly relics which were presented in the Peruvian department of the Centennial Exhibition, and those brought to this country by Dr. Steere. It has been estimated that in the Province of Tarapaca, within fifty square leagues, the quantity of the niter is not less than 63,000,000 tons. The appropriation of this vast resource has been taken up rather slowly, but has much increased for ten or twelve years past. Vessels laden with it go to the coasts of manufacturing countries. At Glasgow the works devoted to the production of ordinary saltpeter from the niter of Peru extend over acres of ground. In 1868, 100,000,000 pounds were used in Great Britain. As yet it has been applied to the nourishment of crops only to a limited extent. But this seems to be its chief destination, and for this use it lies in the earth, a vast mine of wealth, for the disposal of coming generations. When multiplied population puts the sustaining power of the earth really to the test, this fund of sustenance on the Peruvian coast must come to outweigh in value the gold and silver mines of the Californian coast.—*Popular Science Monthly.*

The Rain-Tree of Peru —Accounts from Peru bring the intelligence that, in the forests near Moyobamba City, a tree has been discovered called by the Indians "tamia-caspi," or "rain-tree," which possesses remarkable properties. This wonderful vegetable production, observes the *Colonies and India*, we are told, absorbs the moisture of the atmosphere, which it concentrates, and subsequently pours forth from its leaves and branches in a perfect shower, and in such quantity that in many cases the surrounding soil is converted into a bog. We are further informed that it possesses this singular power to a greater degree during the hot dry weather, when the rivers are at their lowest and the water most scarce. It has been suggested to the Peruvian Government by a gentleman who has examined these trees that the experiment of their culture in the more arid parts of that country should be made, with a view to the benefit of agriculturists.—*The Engineering and Mining Journal*, xxiv, 183.

—The equipment of the Billerica and Bedford, Massachusetts, two-foot-gauge road consists of two engines which weigh, with coal and water aboard, eleven tons; two passenger cars, which weigh from four to four and a half tons each; two open excursion cars, 5,500 pounds each; one box freight car, 5,600 pounds; six flat cars, 4,500 pounds each; two hand and two push cars. The passenger cars are hung low, the floor of each (as of all the other cars) being less than two feet above the top of the rails, so that with a single step a passenger can easily mount from the road-bed into the car. The steepest grade is not over 80 feet to the mile.—*Railway World*, iii, 846.

—During the seven months ending July 31st, England exported 126,684 tons of steel rails, as against 63,737 tons last year, up to the same date, but, on the other hand, she only sent off 112,427 tons of iron rails, as compared with 133,063 tons last year, thus proving that steel is rapidly replacing iron.

—The Providence Tool Company, having re-established satisfactory financial arrangements with the Turkish government, have resumed work on their contract for the manufacture of arms, putting at work again the full force of 1300 men.

—The Market Street Railway Company have been running on trial, a new patent steam dummy, built by the Baldwin Works for St. Petersburg, Russia. The engine and boiler are in a separate car from the passenger coach, and the whole arrangement is twelve feet long. The one on trial has given satisfaction, and will be shipped to Russia this week.

—The Leighton Bridge & Iron Works have just completed two bridges for the Boston & Albany road, at Riverside and Rochdale, and have begun one at Brimfield.

—The Cleveland Car and Bridge Company have just shipped four new street cars to Manchester, New Hampshire, and have every prospect of getting a large order from some point in Canada. They are also constructing a number of bridges, besides doing other work.

—Reese, Graff & Woods are running night and day on an order for bridge iron from the American Bridge Company, to be used in replacing the Omaha Bridge.

—The slate quarries in and around Slatington that had been temporarily suspended, have all resumed work, some with an increased force of men.

—By a recent invention buttons are fastened upon cards by machinery instead of by hand as heretofore. One machine will do the work of twenty skilled workers.

—Ewd. P. Allis & Co. of Milwaukee, are furnishing machinery and water wheels for a 5-run mill at Christchurch, New Zealand.

—With a telephone and a wife a man ought to hear all that's going on.—*Danbury News.*

—The report tests of the steam boilers made at the Centennial Exhibition is now being published. There were 14 boilers tested, one of which used bituminous coal.——Mr. Shaw, of England, says, in a paper, "we are of opinion that sufficient care has not been exercised in ascertaining the quantity of water said to be evaporated."——A dynamometer has been designed by Mr. Fronde to test the power delivered to the screws of large marine engines.——America is given praise for the business-like manner in which they manage the annual meetings of the Association for the Advancement of Science.——Dr. Ray Lankester says that "America is rapidly becoming the headquarters of palæontological research."—— The biography of an infant, giving the intellectual development, by Darwin, has been published.—Dr. Tschaplowitz has been experimenting upon the temperature of leaves; until noon he found their temperature lower than that of the atmosphere, but after one o'clock the difference was generally the other way.——The copper mines of Newfoundland rank among the first in the world in the amount of ore raised and sent to market. The ore is the ordinary pyrites, carrying from 7 to 16 per cent. of metal.——A compliment is paid to the United States Government by the *Pop, Sci. Review*, for its liberality in the matter of science as evidenced by the beautiful and accurate scientific work it publishes in connection with the survey of our territory.

ANSWERS TO CORRESPONDENTS.

LASTING WOODS. (N. S. D., Utica, N. Y.) The darkest are generally the most lasting, where the wood is colored at all. Dull chalky timber is bad. Those woods with least resin or gum are generally the strongest and most lasting.

MEASURING ALTITUDES BY THERMOMETER. (A. G. M., Denver, Col.) The boiling point of water falls very nearly 1° F. for each 543 feet above the sea level. A better formula is $h = 517\ (212° - T) + (212° - T)^2$; when T is the boiling point at the station, and h the height above sea-level.

ERRORS IN BLASTING. (F., Conshohocken, Pa.) Two common faults are (1) drilling in the wrong place, and (2) charging according to depth of bore instead of according to the resistance. Do not make a cannon of the bore; drill parallel with the seams of stratified rock, and in igneous, rather inclined than perpendicular to the outer surface. In homogeneous rock, charges of powder to do proportionate work should be as the cubes of the lines of least resistance; thus, if 4 oz. of powder would have a certain effect on a piece of rock two feet thick to the surface, it would require 13½ oz. to produce the same effect on a piece three feet thick, because $2^3 : 3^3 : : 4$ oz. : 13½ oz. With high faces, undermining should be used. Clay is the best tamping; broken bricks the next. A pound of powder should loosen from 7,000 to 14,000 lbs. of rock, and will fill an inch hole 38.2 inches deep.

STONE MASONRY. (S. H. S., Albany.) The general principles are: build the courses perpendicular to the direction of the pressure they must bear; avoid long continuous joints by "breaking joint;" use the largest stones for the foundation course; lay stratified stone with its layers perpendicular to the pressure; "bond" well; moisten dry and porous stones before bedding; do not use too much or too thin mortar.

POWER REQUIRED IN PUNCHING METAL. (O. N. R., Louisville, Ky.) A one inch hole in a one inch plate would take a pressure of about 3.14 times the ultimate tensile strength of the plate, say $3.14 \times 60{,}000 = 188{,}400$ lb. In fact, a strip of metal 3.14 times the diameter of the hole has to be sheared off.

BEARING STRENGTH OF PILES. (C. F. C., St. Louis.) If you drive them in clay or wet soils, 15 tons is a maximum weight to place on them; but in gravel almost any weight may be put on them.

ROTTEN ROCK. (K., Chicago.) Shale under ground is tough and hard to blast; but the air very soon decomposes it.

HORSE-POWER OF ENGINES. (R. B., Macon, Ga.) We do not know any body, or any book, that can tell anything "*definite*" on the subject. Nobody knows how much a horse-power is, nor how to determine how many an engine exerts when a standard is agreed upon. It is all approximation thus far.

THE SLIDE VALVE MOTION. (E. D. C., Harrisburg.) In view of the fact that Mr. Bilgram is at present explaining this matter in our columns, we prefer not to reply here.

STRESS OF FIBRES. (J. T., Tiffin, O.) The stress in any fibre is proportional to its distance from the neutral surface.

METAL DRILLS. (A. R. W., Phila.) They are *chiefly* distinguished from those for wood by having two similar cutting edges.

REAMERS. (C. A. Y., Keokuk.) "Rimer," "Rymer," and "Reamer" are all three admissible. We do not think that "Rimmer" is correct.

MULTIPLE PUNCHING MACHINES. (A. M. M., Peoria,) Messrs. Roberts, of Manchester, invented a punching machine to produce any arbitrary arrangement of holes.

FORCE REQUIRED FOR PILE DRIVING. (G. F. B., Wilmington, Del.) This varies greatly. The force of the ram is equal to its weight multiplied by its velocity, and when s equals the time of descent, the velocity on striking the pile is $32\frac{1}{6} \times s$. The fall in feet equals $16\frac{1}{12} \times s^2$; and $s = \sqrt{\frac{f}{16\frac{1}{12}}}$. The momentum is equal to the weight $\times\ 2\sqrt{16\frac{1}{12} f}$. The amount of actual penetration depends upon the hardness and elasticity of the soil, the sharpness and straightness of the pile, etc.

GETTING FOUNDATIONS. (T. H. H., Newark, N. J.) As your bearing surface in the first case *underlies* deep soft ground, you may (1) drive timber piles and then withdraw them and fill the hole with sand, gravel or concrete; (2) drive wood or iron piles; (3) screw in iron piles; (4) lower iron cylinders, removing the soft material. In the second case, of a good crust over a treacherous bottom, do not disturb the ground by ramming, or by driving piles, or by cutting. Reduce the weight of the building and distribute over a large surface. If the substratum is simply compressible, weighting the foundations before building on them may aid you. If it is soft soapy clay, do not ditch or drain it near the work, as it will *slip*. If it is sand it is likely to flow if exposed to the action of water.

BIBLIOGRAPHICAL NOTICES

A TREATISE ON THE USE OF BELTING FOR THE TRANSMISSION OF POWER. By John H. Cooper, M. E. Fully illustrated. Philadelphia: Claxton, Remsen & Haffelfinger, 1878. 310 pp. 8vo, cloth. Price $3.50.

Since the author of this excellent and exhaustive work commenced his extended labors of collection, from all sources at his command, of *Belting Facts and Figures*, and published these, as the facts were obtained, in the *Journal of the Franklin Institute*, the public has looked anxiously for their appearance between one pair of covers, and with full index, cross-references, and general deductions. On the subject of belting we have had really no standard treatise, giving clear, direct and simple rules, formulæ and tables for every condition of varied use, and based upon actual practice. Before Mr. Cooper commenced his collection (at first for his personal use), the literature of belting was scattered through various treatises and periodicals, published dozens of years and thousands of miles apart, and in no sense accessible to the general reader, nor in shape for ready consultation even in the great libraries. When we state that the amount of belt-surface per minute to transmit a horse-power has been variously rated at from 34 to 400 square feet; that the advocates of leather, rubber and combination beltings, of wood, iron and leather surfaces, and of all sorts and modes of dressing and joining, have more frequently based their statements upon whims or incomplete experiments; and that rival dealers have in many cases falsified figures to advance their own interests,—we may very well thank Mr. Cooper (who has no hobby to ride) for his almost herculean task of bringing conflicting opinions side by side, and of evolving from the great mass of matter some reliable rules and data, readily available in every-day practice in the workshop. The author has done justice to himself, the reader, and his sources of information, by scrupulously crediting each borrowed item; for which, in these days of literary piracy, he deserves special commendation. The author's own opinions are given on pages ix and xi; and as they are founded upon experiment, backed up by good authority and verified by long practice, the reader may depend upon them. Some of the conclusions reached are that good single leather belts ¼ inch thick have 1000 lbs. of tensile strength per inch of width, ordinary belts 750; and that owing to fastenings, &c., 200 lbs. per inch of width may be depended upon for ultimate strain. (Data bearing upon other kinds of belts are less known, the only important ones being tabulated on p. 213.) Every inch of width of good leather belt will safely and continuously transmit a force of 55 lbs. on smooth, high-speed pulleys. Belting averaging 1-6 inch thick, this would give 330 lbs. stress* per square inch of section. This stress of 55 lbs. per inch of width corresponds to a surface velocity of 50 square feet per minute per H.P. safe for good single belts; double belts permitting proportional stress (in all cases ample pulley contact being required). On page x is given a valuable new table for converting the strain of a belt into surface velocity per H.P. In the "Conditions to be fulfilled in the use of belts," p. xi, is given the cream of the whole subject of belting. This page we shall reproduce.

The rule for work of belt of Mr. Webber (who made the Centennial turbine tests) agrees with that given by the Page Belting Company, and is adopted by Mr. Cooper; it is, that "ordinary leather belting one inch wide, having a velocity of 600 feet per minute, will transmit one H.P." The author has devised and adopted convenient abbreviations—*Fpm* and *Rpm* for "feet" and "revolutions" per minute respectively.

Mr. Webber's table of the friction of shafting (p. 20) is new and valuable.

"Rules and Facts" take up about one-half of the book; the remainder exhausts all that is known of belting and kindred matters. The fifth chapter gives the text and results entire of Mr. Robert Briggs' elaborate essay and Towne's experiments upon leather belting. The seventh chapter is a literal translation of Morin's treatise on leather-belt tension, and gives every figure, formula and tabular statement as in the original—something never before done, to our knowledge. The eighth chapter treats of rope-transmission and gives Roebling's data, and also a translation from the French of Achard. The ninth chapter is a treatise by Wicklin on transmitting power by rolling contact; and although, like some other matters, it might appear irrelevant, yet we need it for purposes of comparison.

As an instance of the thoroughness of the book, we may mention that there are illustrated *nine* methods of applying the quarter-twist belt! We only regret that there were not more data obtainable on the subject of rubber belting; paper-covered pulleys; the relative driving capacities of belts and gears when driving in the same machine; available rules for calculating the loss of belt adhesion from centrifugal force; minimum amount of pulley contact per H.P.

The work as we have it may well be forgiven its great mass, on the score of its great completeness and fidelity, and we confidently welcome it as the standard treatise on belting. G.

THE METALLURGICAL REVIEW. Vol. I, No. 1. September, 1877. Published monthly by David Williams, 83 Reade street, New York city.

We have just received the first issue of this new metallurgical magazine, which, from its admirable appearance and contents, gives promise of becoming a valuable addition to American technical journalism. The leading paper, on "The Mechanical Treatment of Metals," is furnished by Prof. R. H. Thurston, a writer of such eminence as to require no identification. Prof. Henry Wurtz also furnishes an article on "Studies of Elemental Iron and its Modifications." All the articles, in fact, are admirable, and if the present issue may be regarded as a fair sample of what the magazine will be, we shall hail its advent with much pleasure, and bespeak for it a very successful career.

SELECTED LIST OF U. S. PATENTS.

AUGUST 14, 1877.

Patents granted August 14, 1877, 234. Reissues, 9. Designs, 11. Trade-marks, 29. Labels, 5.

194,050. PROCESSES FOR RECOVERING PHOSPHORIC ACID USED IN MANUFACTURE OF GELATINE. Nathanial B. Rice, East Saginaw, Mich.

Dissolves the bone with phosphoric acid, leaving the gelatine; precipitates the lime by SO_3, drains out the phosphoric acid, leaches the phosphoric acid solution of next lot through the sediment of the first, which carries off the phosphoric acid from the Ca_2O, SO_3, thus displacing it by an acid phosphate of lime, the residuum available as a valuable fertilizer. Subjects each lot to the action of SO_3, and then leaches a part or the whole of the next lot through the sediment of each preceding.

194,052. CROSSCUT-SAW HANDLES. C. A. Root, Andover, Ohio, assignor of one-half his right to L. W. Merrell, same place.

The handle is attached to the saw, so that it may be used at right angles to the sides of the saw or in a right line therewith, by means of two clamping plates, the inner one having a longitudinal and transverse groove, a bifurcated bolt hooked into holes in the saw blade, and a thumb-nut for securing the whole in position.

194,056. ATTACHING DOOR KNOBS TO SPINDLES. Ai B. Shaw, Medford, assignor to M. W. Carr, Somerville, and H. W. Brooks, Cambridge, Mass.

A spring-pin passes through the knob-shank into the spindle, and is held in place by a loose collar placed over the knob-shank.

194,059. ORE JIGGERS. S. Stutz, Pittsburg, Pa.

The plunger, by the peculiar construction of the steam valves, has a slow upward and sudden downward movement, so that the space under the plunger, when raised, will be filled from the supply pipe alone without producing backward current from the separator-box.

194,062. SHIRRED FABRICS. S. Wales, New York, assignor of one-half his right to N. H. Furness, Tarrytown, N. Y.

The elastic foundation may be a woven fabric rendered elastic by threads of rubber, or a sheet of rubber re-enforced by an open-woven fabric, to prevent the holes made by the needle in sewing cutting out. This foundation, in a distended state, is combined, by sewing, with non-elastic fabric, which results, when the elastic is set free, in an elastic fabric presenting a surface shirred to various patterns, according to the patterns formed by the lines of sewing.

194,067. LOCKING DEVICES FOR DRIVE WHEELS FOR SEWING MACHINES. G. W. Baker and D. A. Porter, Cleveland Ohio.

The outwardly swinging frame is pivoted to a collar upon the shaft to lock the drive wheel. It is adapted to be readily disengaged from the wheel, permitting it to be revolved either forward or backward.

194,070. SEWER, STENCH AND GAS TRAPS. B. P. Bower, Cleveland, Ohio.

The valve is exposed to view through the removable glass section. This trap has a removable glass section at the bottom, and a floating spherical valve which automatically finds its seat at the lower end of the down pipe, which extends down into said removable glass section. It can therefore be observed from the outside.

194,079. MACHINES FOR BARRING BUTTON HOLES. L. Dustin, Elizabeth, N. J., assignor to the Singer Manufacturing Company, New York.

When the clamp plate has reached the end of the feed movement, and the sides and eye of the button hole have been stitched, a movable guide is operated by a hand lever, to throw the clamp to one side, so that the needle will operate on both sides of a line continuous of the slit of the button hole, and form a bar across the end, the feed being stopped during the barring.

194,108. CULTIVATORS. J. Poetz, Shakopee, Minn.

Fixed centre-beams, on which is mounted a rotating plate. Two or more outer swinging beams on each side are connected, by rods, to the plate at different distances from its pivot point, so that the beams shall be at equal distances from each other, whether spread or contracted.

194,110. MACHINES FOR PICKING AND BURRING WOOL, &c. C. G. Sargent and F. G. Sargent, Westford, Mass.

The fibres are taken from the feed-rolls by a picker-cylinder armed with alternate brush and toothed lags, and passed to a burring cylinder, from which they are transferred with the other side outward by a rotary transfer brush to a second burring cylinder revolving in the opposite direction to the first. Guard cylinders opposite each burring cylinder remove the burrs and other foreign matters. A fan, through suitable openings, removes all dust from the wool.

194,113. PROCESSES FOR TREATING AND RESTORING THE METAL OF OLD CAR WHEELS. George W. Swett, Troy, N. Y.

The process of rendering the metal of which old car wheels are composed capable of use again for the same purpose, by subjecting the metal in a reverbatory furnace to the action of a carbonizing flame until a highly heated state of fluidity is obtained, and then to the action of a decarbonizing flame, and subsequently carbonizing the metal by adding spiegel or franklinite or No. 1 or 2 iron.

194,140. WINDMILLS. O. B. Fuller and L. A. Fuller, Mount Pulaski, Ill.

The wheel revolves upon a journal formed upon, or attached to, the outer end of a bar or beam. The inner end of the bar is rigidly attached to the upper end of the tube, which works in the keepers attached to the post, frame, or tower that supports the wheel. The lower end of the tube revolves in a hollow step attached to the post, frame, or tower.

194,141. PROCESSES FOR RECOVERING ALKALIES USED FOR THE REDUCTION OF WOOD TO PAPER PULP. H. H. Furbish, Yarmouth, Me.

The process of economizing the alkaline solution used for reducing wood or wood chips to pulp for paper manufacture, which consists in washing the spent lees from the cooked mass in water heated as herein described—that is, by steam blown off from the cooking vessel—evaporating the water, recovering the ash in a recovery furnace, boiling and rendering the recovered ash caustic by lime, evaporating the same, and reducing it to the proper strength for use, as herein described.

194,168. MACHINES FOR SHEARING SHEET METAL. G. H. Perkins, Philadelphia, Pa., assignor to Le Conte & Perkins Manufacturing Company (limited), same place.

The tension of an endless band is regulated by adjusting the bearings of the lower rollers, over which it passes. A shouldered wheel, acted on by a spring, presses the sheet against the opposite side of the feed chute. The drums carrying the cutters are made in sections, adjustable toward or from each other, in virtue of which the cutters can be set to the desired distance apart, and the machine enabled to shear sheets of different widths.

194,190. CULTIVATORS. J. C. B. Thomas, Palmyra, Mo.

The axle of each wheel is bent upward, inside the wheel, to a vertical position. They are held in proper position by a connecting cross-bar, which is adjustable up or down on said axles and held by set-screws. Said cross-bar is also adjustable in its sockets so as to permit the wheels to be moved forward to adjust the wheels.

194,237. CIRCULAR SAWING MACHINES. F. D. Green, Williamsport, Pa.

The saw mandrel is mounted on a vertically adjustable saddle attached to a sliding carriage, so that it will compensate for wear, and cause it to cut higher or lower in dadoing. The sliding carriage travels in rocking ways, which admit of the adjustment of the saw to cut any desired angle. The proper tension on the belts in all conditions is maintained by suitable pulleys mounted in a frame working in curved guides.

194,269. SPINNING MULES. Heinrich M. Schon, Crimmitzschau, Saxony, Germany.

The carriage supports two sets of cop-spindles, one set above the other, an upper and lower set of faller-wires, operated by a single faller-bar, an upper and lower set of cord-drums, and mechanism for operating the whole simultaneously from a single head stock, which also supports a double set of drawing-rollers. A single quadrant or winding-on motion operates the two sets of spindles. A network of cords stretched from the carriage to a point beneath the upper set of drawing-rolls serves to catch broken yarns falling from the top tier of spindles.

* The author uses the word "strain." Recent usage, and the sanction of such eminent authorities as Rankine and others, define "stress" as a force tending to move or deform a body, and "strain" as the result when the stress produces a permanent deformation.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

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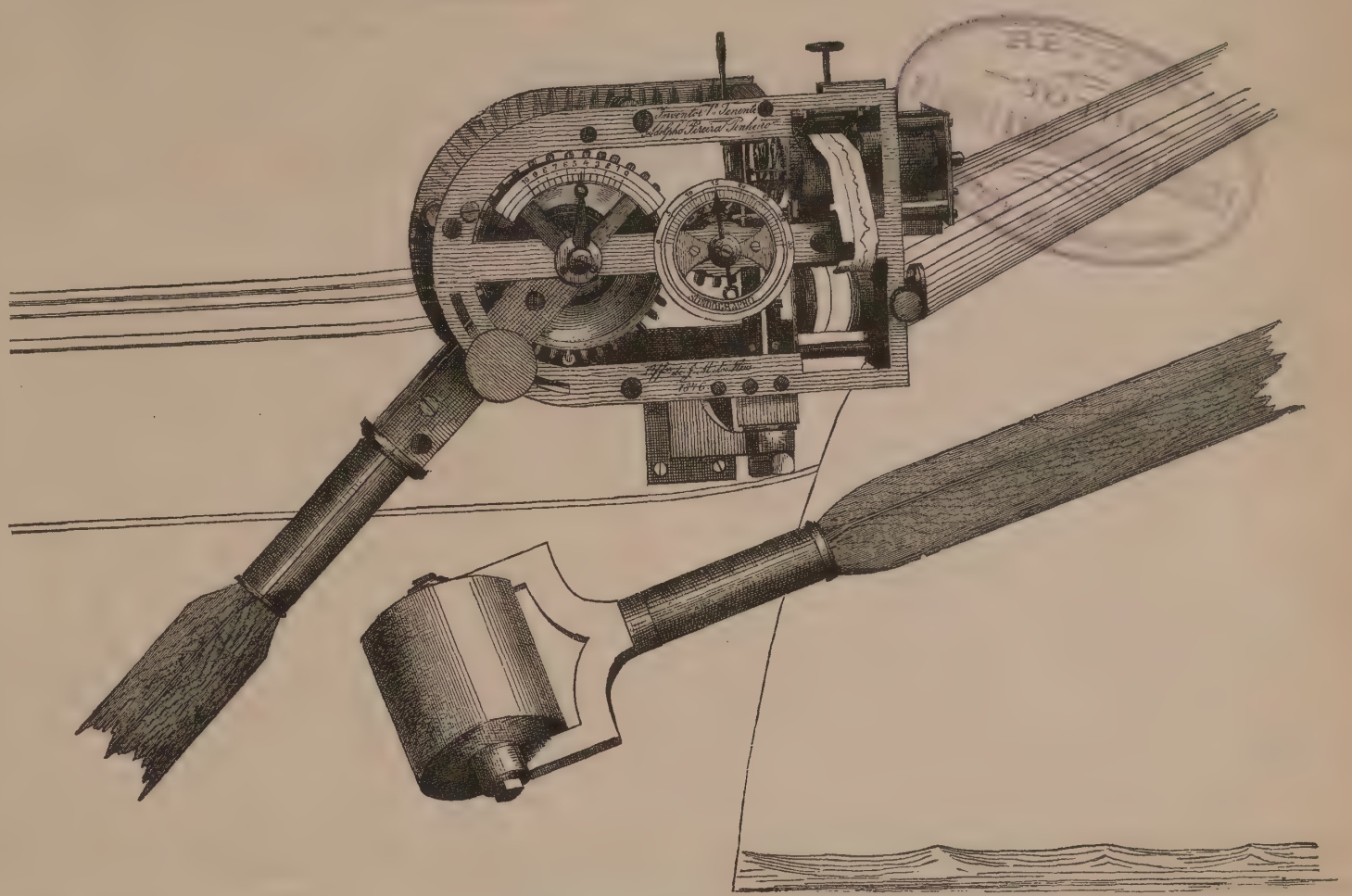
THE SONDOGRAPH.



By the courtesy of the *Aurora Brazileira* we lay before our readers an invention, contrived by Capt. Echebarn, of the Brazilian navy, and Mr. Pablo Durgos, to indicate and register the depths of water in the Rio da Prata, which, from the continual shifting of its banks and the great velocity of its waters, presents great difficulties to navigation. There is a long rod, turning on an axle which is provided with a toothed wheel, and which axle bears an index pointer, indicating on a graduated arcs the inclination of the rod from the horizontal. The lower end of the rod bears a roller which travels on the bottom of the river, or the body to be indicated. Evidently the elements given are the hypothenuse of a right angled triangle (the length of the rod) and the angles, from which the vertical, the hight of the instrument from the bottom of the river, can be readily determined. The toothed wheel mentioned drives a wheel-train bearing a paper drum, and on a paper band a pencil describes in miniature the condition of the bottom in the line traversed by the vessel. G.

PLATINUM AND ITS USES.

This metal was discovered as long ago as the middle of the last century, in the form of grains and pebbles in the auriferous alluvial deposits of Brazil, Choco and Barbacoa in South America, where it occurs associated with osmium, iridium, rhodium, palladium, gold, copper, iron, and other metals. Its name is a diminutive of *Plata*, silver, and was applied to it because of its resemblance in color to that metal.

The metal was first brought to Europe by Wood in 1741, and the Spanish mathematician, Antonio de Ulloa, who first discovered the metal in Brazil, in 1735, gave the first accurate description of its properties.

Its identity as a new element, however, was only definitely established some years later, by the joint investigation of a number of savants, among whom the more prominent were Schaffer, Director of the mint in Stockholm, Wollaston, Berzelius, and Döbereiner. Platinum is only found native, combined almost invariably with a greater or less proportion of iron, iridium and other metals allied to it in chemical properties. In addition to its discovery in numerous localities in South America, it has been found in Mexico, in San Domingo, in Borneo, in the sands of the Rhine, at St. Aray; val du Drac; in county Wicklow, Ireland, in the gold region of California and in Oregon; associated with gold in Rutherford Co., North Carolina; at St. François, Beauce, and other localities in Canada East; but in the by far largest quantities, in the alluvium or drift material on the western slope of the Ural Mountains. Generally speaking, platinum occurs in quite small grains, but occasionally masses are found of considerable magnitude. Humboldt, for example, deposited in the Berlin Museum, a mass weighing 1,088 grains; another mass found in the Ural mines weighed 11.57 lbs. troy; the largest mass yet found is from the same mines, and weighs 21 lbs. troy. The perfect separation of platinum from the closely allied metals, osmium, iridium, rhodium, palladium, &c., that accompany it, is a very tedious and delicate operation, and quite impossible to carry out commercially. For practical purposes, the complete separation of iridium, which is generally the most abundant associate of platinum, is not desired, as the presence of a small quantity of the former, in commercial platinum, greatly adds to its hardness and tenacity.

The chemical details of the process of separation and purification are somewhat complex, and need not be entered into here.

Platinum is too refractory to be fused in the furnace, but at a high temperature its particles cohere like those of iron, and it may, like that metal, be welded. Hence, by heating a mass of spongy platinum, as obtained from the operation of refining, and which has previously been strongly compressed, and submitting it to increasing pressure, the mass comes to be so far compacted that it may be forged with the hammer.

As it comes from the hands of the workman, platinum is highly malleable and ductile. It has a grayish white color, between that of silver and zinc. When perfectly pure, it is softer than silver, and susceptible of a high polish. The ordinary commercial products, which invariably contain some iridium, (which, as above remarked, increases the hardness, infusibility and wearing qualities,) may be drawn into wire of $\frac{1}{1940}$ of an inch diam.; but if it is made the core of a silver wire, it may be drawn out so thin as the $\frac{1}{30000}$ of an inch diam.

In point of tenacity, platinum approaches closely to iron. The presence of iridium, as above remarked, increases the hardness of the metal, but reduces its durability.

The finely divided metal (platinum sponge) as left behind in igniting the double chloride of platinum and ammonium, possesses, in a remarkable degree, the property of condensing gases within its pores, which occurs with energy enough to liberate sufficient heat to inflame gaseous mixtures—a property that is utilized in the celebrated and once commonly-used hydrogen (Döbereiner's) lamp. The specific gravity of platinum, owing to the great difficulty of obtaining it chemically pure, has never been ascertained with absolute certainty, but according to the results of several investigators, varies between 21 and 22. It ranks, therefore, amongst the heaviest of known substances—exceeding even gold in this property. The metal, although it resists the most intense furnace heat without melting, becomes soft at a very high temperature, and may be worked. Before the compound blow-pipe it fuses; and Dr. Hare succeeded in 1837 in melting 28 ounces in one mass.

Platinum is insoluble in all acids, and is only attacked by such substances as contain or yield free halogens, such as *aqua-regia*. It is, however, attacked by caustic alkalies where free access of the air is permitted, or by saltpetre, if these substances are fused in contact with it. Sulphur, phosphorous and arsenic have little effect on rolled platinum.

The infusibility of this material, its hardness and ductility, in virtue of which, it may be rolled into the thinnest leaves, or drawn into the finest wires, and its indifference to the action of the air and moisture and nearly all chemical agents, have caused it to be used for a great variety of purposes, the most important of which are for the construction of philosophical and chemical apparatus, as crucibles, retorts, evaporating dishes, for platinum vessels of enormous size which are used in the sulphuric acid manufactories, for the concentration of the acid; while a great variety of platinum vessels are used in the laboratory, for the most various purposes connected with chemical analysis. The metal was at one time largely employed for coinage in Russia, a use for which its hardness, excellent wearing qualities, and great weight, appear to fit it, but for some reason, probably the difficulty of working it, or possibly prejudice, it appears to have been withdrawn from circulation. It has been used as a covering for other metals, but though more permanent, cannot compare in brilliancy with silver or nickel, and is not likely to come seriously into competition with those metals for that purpose.

Concerning the treatment of platinum vessels, the following hints may be found useful: They should never be placed amongst coals, and exposed in this way to the direct action of a coal fire, as the silicic acid contained in the glowing ashes will attack

the metal at this temperature. If necessary to expose the crucible to the action of such a fire, it should be placed within a Hessian (sand) crucible, upon a bed of magnesia. Where the flame of a spirit lamp or of a Bunsen gas flame is used to heat it, care should be taken that no carbon is deposited upon the crucible, as a compound of carbon and platinum could be formed, which will show itself by the formation of a rough and matt surface.

Neither should easily-fusible metals, nor mixtures from which, at the red heat, such metals may be reduced, be heated in the crucible, as the result will be the formation of alloys with the platinum, and the destruction of the vessel. Nor should substances be smelted therein which will yield free chlorine, bromine or iodine, sulphur or phosphorus, nor iodides, bromides or sulphides of the alkali metals. Hydrate of potassa and saltpetre attack platinum quite strongly, and should be fused in a silver dish or crucible.

It may be well to add, in conclusion, a few words concerning the platinum industry in this country, and present the following statements thereon upon the authority of Mr. H. M. Raynor, of New York, who (having the field practically to himself) has made a specialty of supplying this important metal in all the forms required in the laboratory, manufactory and elsewhere. The chemical vessels produced by this manufacturer are *hammered* into shape from plate of the greatest possible density (imitating, in this respect, the treatment of the metal by which the French makers gained their reputation); the cheaper spinning process, sometimes employed, having the injurious effect of opening the texture of the metal and rendering crucibles and dishes so made, short-lived and unsatisfactory.

The large number of these and other laboratory vessels (running into the thousands) which have supplied for use in the mining schools and other departments of our colleges, to the almost complete exclusion of the foreign-made articles, is evidence that this branch of industry has been well learned, and is now thoroughly domesticated in our own country.

For the refined metal in rod and ingot we are dependent as yet upon the laboratories of Europe, which absorb the entire product of the crude or "native" platinum of the Ural district, the supply from our own mining localities being still meagre and uncertain. The annual yield from the Russian mines is about 4000 pounds.

W.

FISH PLATES.

The improvements in the permanent way of railroads, during their history in this country, must be apparent on the most cursory observation. Within the memory of many now living, the rails were simply timber bases holding iron straps on their upper surfaces, succeeded by rails made wholly of iron, secured to sleepers either of stone or wood. The former material was found to present too rigid and unyielding a surface, inducing a large amount of wear to the rolling stock consequent on the continual jar. This wear was first partially lessened by the introduction of shims of wood between the rails and the stone sleepers, and finally the stone were replaced by wooden sleepers. The use of chairs to receive the ends of the rails was a step in the right direction of reducing the wear both on the rolling stock and the rails. But it was found that the cast iron chairs were frequently breaking, and chairs of wrought iron were substituted. Still further improvements were found to be desirable, as the ends of the rails could not be securely held, each end yielding under the load of the train and rapidly brooming out. It became necessary to so connect the ends as to make them in effect a continuous rail. Indeed, a continuous rail was tried in some localities, the rails being made in vertical sections and riveted together as the work of laying the rails progressed. But the allowance for expansion and contraction, occasioned by the extremes of atmospheric temperature in this climate, was too small, and the continuous rail-system was abandoned. Then came the first attempts at the use of the fish plates, a connection of the rails being made by means of strips of scantling, the timber in some cases being laid from sleeper to sleeper under the rail as well as on the sides. It was evident, however, that this was but a bungling and inefficient method, owing to the perishable nature of the material employed. The result was the production of the rolled iron fish plates, which are now fast superseding all other devices for retaining the ends of rails in place and constituting in effect a continuous rail.

It is but a few years since these have been adopted in this country—less than ten—but unless some entirely different and superior device is invented they will become general, at least on well-managed roads. The plates are rolled to conform on their inner surfaces to the concavity of the rail between the tread and base, and are recessed on the outer side to receive the heads of the bolts on one side and the washers and nuts on the other. They are made about eighteen inches long, secured to the rails by two bolts in each rail, the ends of which are usually supported by a sleeper. Some roads, however, prefer to depend for the support of the rail ends entirely upon the fish plates as giving a more elastic road for the wheels. There is no conflict of opinion in regard to the benefit of the fish plate in lengthening the life of the rails, nor in reducing the wear of the rolling stock. Objection is made, however, by some on account of the difficulty of keeping the nuts on the bolts secured, the jar of trains loosening them in spite of all devices, and necessitating a constant supervision and examination. The usual and best method of fastening practiced is to employ a hollow washer, or shell, of malleable iron, which is seated next the rail and contains a thick gland of hard rubber. On this the nut is screwed, the theory being that the rubber being elastic receives and dissipates the vibration before it reaches the nut. But in practice this is found to be an error, the section hands on the best kept-roads being constantly employed in setting up the nuts. It would seem that a differentially threaded bolt with two nuts would meet the requirements of this case, and the suggestion is here made that it be given a trial. The idea is that the bolt should be enough longer than at present to receive another nut, but that the outer, or check nut, should be threaded a different pitch from the holding nut. Thus, suppose the holding nut be threaded ten to the inch let the check nut be threaded twelve to the inch, the outer, or check nut, portion of the bolt to be, of course, the diameter of the thread smaller than the inner, or holding nut portion, to allow the latter to pass. In action, the holding nut, in unscrewing, would recede from the rail one-tenth of an inch in one revolution, but, at its first retrograde movement, it would come against the check nut, which could move only one-twelfth of one inch in an entire revolution. The result would be a more intimate contact of the engaging faces of the two nuts, so that the effort of the holding nut to free itself would only bind it the faster. Of course, this supposed action is predicated only on the theory that the disengaging jar from the rail is received first by the inner, or holding nut. But, if the reverse should be the case, and the jar first affect the outer nut, the circumstances and result might be reversed, or at least greatly modified. This can only be ascertained by experiment, for the facts of the effect of vibrations upon fixed bodies, especially upon engaging screw threads, are of such a character as not to be easily explained upon any hypothesis susceptible of demonstration. In a future article some of these facts may be treated.

In application the bolt-holes through the web of the rails are slots allowing an end movement of one-fourth of an inch each way, and when the plates are secured—usually in summer—one-eighth of an inch opening at the ends is left. It has been the custom to punch the slots in the rails while hot, which does not weaken the rails, but to drill the bolt holes in the plates, an upright drill with four simultaneously acting drill spindles being employed. But as the plates are rolled it would seem that no valid objection can be made to the cheaper process of punching while hot.

J. H. L.

ELECTRO-PLATING.

The value of the galvanic current as an agent for effecting the dissociation of chemical compounds was established by Sir Humphrey Davy as long ago as 1808, when with its aid he succeeded in proving that soda, potassa, lime, &c., were metallic oxides and not elementary substances, as had previously been the universal belief.

It was not, however, until many years after this that this decomposing power of the battery was applied to useful purposes in the arts. It was soon observed, however, that metals deposited by its agency, from their solutions, assumed various fantastical shapes, which so closely resembled the growth of vegetation that they were not inaptly styled galvanic trees. But these observations might still have remained of no utility save to awaken the interest of students of chemistry by their beauty as experiments, had it not been for an accidental discovery by Professors Wagner and Jacobi, in 1830, that the metallic deposits thus obtained might be used for plating and copying. A history of this discovery will not be uninteresting: These investigators were endeavoring to solve the enticing problem of employing electro-magnetism as a motive power in place of steam. Jacobi employed a Daniell's Battery, which is distinguished by its constant and regular action, the elements of which are too well known to our readers to need description here. When the battery is working, the sulphate of copper solution employed is slowly decomposed, depositing metallic copper, which finally becomes injurious, and must be removed. Once when Jacobi was busied removing such a deposit from his battery, he noticed that there were several layers of copper, each having the form of the sides of his copper vessel. He noticed that these layers did not belong to the sides of the vessel as he had at first supposed, but to a new deposit of metal, which imitated, in a remarkably perfect manner, the shape of the surface of the walls. It at once occurred to Jacobi that this to him very troublesome phenomenon could be turned to profit by employing it for reproducing objects in metal. In 1838 he communicated to the Academy of St. Petersburg a description of his discovery of the use of galvanic electricity for reproducing objects in the arts. The discovery attracted such attention that the Emperor Nicholas, after satisfying himself of its great value, gave the discoverers the means of making his new art the common property of the world.

We do not propose here to enter into details of the methods employed for various applications of the galvano-plastic art, since the purpose of this sketch is simply to present briefly a historical account of its development. It appears that up to the year 1840 it was only employed for making small copies like coins and medals, and even these were often very imperfectly reproduced. About this time, however, Prof. Boettger succeeded in producing handsome relief plates of copper, employed the battery also for depositing a metallic coating upon other metals, as for example, gilding silver, copper and brass. The following year this ingenious chemist made a copy of one of Felsing's copper plates, (the *Ecce Homo*, after Guido Reni, $12\frac{1}{2} \times 9\frac{1}{2}$ in.), which proved to be so perfect that the engraver admitted that proofs printed with it were not to be distinguished from those taken from the original. (These plates are still preserved.) About the same time, also, an engraver named Kress, who had learned the galvano-plastic art in St. Petersburg, obtained the idea from Prof. Jacobi that the process might be employed for obtaining copies of his electro or engraved plates—thus multiplying the original plate as many times as might be desired, and permitting of the production of an unlimited number of excellent impressions, without in the least impairing the sharpness of the original. The engraver in question made such use of the suggestion that, so early as 1844, he had brought the art of electrotyping, now so universally used and so indispensable, to the rank of a successful business.

The galvano-plastic art from these beginnings has developed into an industry of incalculable value to the printer, the publisher, the engraver and artist. Its employment in reproducing copies of engravings and letters is almost as universal as stereotyping, to which it is superior for these uses, presenting a harder surface for wear in the printing press, while it affords the same advantages in permitting of the unlimited multipliclation of an original which was previously the eminent and exclusive merit of the art of stereotyping. A development of the galvano-plastic art in this direction, and which has been carried to great perfection in France and Germany, consists of the production of objects formerly cast in metal. In Mayence, for example, the smallest natural objects are copied and largest works of art produced. Paris is likewise famous for excellence in this field of art.

In another direction, the galvano-plastic art has originated a great industry, the value of which, from the vast variety, popularity and utility of its products, it would be difficult to over-estimate. We refer to the electro-plating of objects of every conceivable description, with gold, silver, copper, steel, nickel, etc. The development of this branch of the galvano-plastic art has been simply enormous, and its indirect educating influence has been invaluable, inasmuch as it has placed with the reach of all classes objects of utility and fancy, of the most artistic designs, which rival in beauty and serviceability the most precious works of art in gold and silver, which are, of necessity, the exclusive property of the rich.

W.

SULPHATE OF COPPER BATTERIES.*

In the simple combination of zinc and copper with a moist conductor, owing to the decomposition of the water, oxide of zinc and hydrogen gas was immediately formed round the copper plate, by which the negative plate became polarized and the current weakened. If, instead of pure water, we use a mixture of water and sulphuric acid as a conductor, a similar analysis of water occurs, but the oxide of zinc combines with the not so easily decomposable sulphuric acid, and forms a sulphate of zinc, which is dissolved by the remainder of the fluid. In this way the metallic surface of the zinc is kept clean so long as there is sufficient water to dissolve the sulphate of zinc which has formed there. The injurious effect of the hydrogen, however, which surrounds the copper plate, and prevents the direct contact of its surface with the fluid still remains; the only thing that can be done to remove it is to surround the negative metal (the copper plate) with a material that readily absorbs the approaching hydrogen, and thus prevents it adhering to the metal. As the hydrogen at the moment of its separation readily unites with the oxygen, the copper plate is surrounded with a material abundant in oxygen, which then transfers a portion of the oxygen to the hydrogen which the current has separated, and causes a re-combination of both gases into water. Hence, the negative metal remains unchangeably in contact with the fluid, and as this is also the case with the positive metal (the zinc), the action of such a galvanic combination remains constant, until either the sulphate of zinc is no longer soluble and the zinc plate becomes covered by it, or the oxygenous material around the copper plate is decomposed.

Daniell was the first to construct batteries of this kind. In order that the oxygenous material which surrounds the negative metal may not mix with the fluid which surrounds the zinc, all these batteries require two cells, or their equivalent. The zinc always remains in acidulated water, and the electro-negative metal in the oxygenous fluid, which is separated from the former by means of a porous cell or partition, insuring a conducting connection with it.

The Daniell Battery.—The Daniell element consists in its present form, as represented in fig. 5, of a vessel, in which stands a porous clay cylinder, *t*. The latter is surrounded by a zinc cylinder, *z*, whilst in the clay cell, *t*, a thin sheet of copper is suspended, which is attached to the copper wire, *a*, connected with the zinc cylinder of the next element. At the upper part of the copper sheet, *C*, a seive-like perforated copper plate, D, is attached, which serves the purpose of holding the sulphate of copper cyrstals.

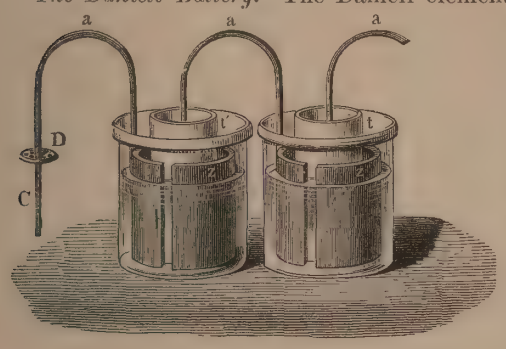


Fig. 5.

In charging the Daniell battery the glass vessel and the porous cup of each element is filled with water, and crystals of sulphate of copper put on the copper plate *D*. In about an hour afterwards enough sulphate of copper will have been dissolved to put the battery in action. As soon as the circuit is closed, owing to the decomposing process which sets in simultaneously with the current, sulphate of zinc is formed in the zinc cups which is decomposed by the water in the cup. The released hydrogen, however, is conducted towards the copper plate in the porous cup, where at the same time a corresponding portion of the sulphate of copper is thrown down in sulphuric acid and the black oxide of copper; the former remains undecomposed, and the latter becomes separated into copper and oxygen. The oxygen which is released from the black oxide of copper and hastens toward the zinc plate meets the hydrogen which starts from the zinc cup; both gases combine, forming water, and the formation of a hydrogen gas around the copper cylinder is thereby prevented. The pure copper which is left from the oxide of copper after the secretion of the oxygen is conducted by the current to the copper cylinders, where it is deposited in a coherent mass.

The maintenance of the Daniell battery requires only the occasional dropping of new crystals of sulphate of copper in the porous cups, to keep the solution at the point of saturation, and an occasional change of the water.

The construction of a Daniell element permits of a variety of different forms. Both vessels may be interchanged; the glass vessel, *G* (fig. 6), may be filled with sulphate

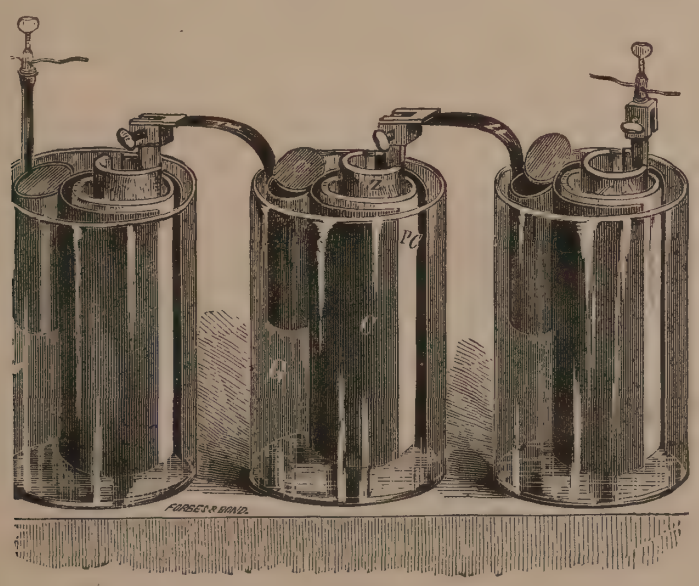


Fig. 6.

of copper, and the porous cell, *P C*, contain the zinc, *Z*; and in order that the action of the battery may commence at once, the copper cups may be filled with a concentrated solution of sulphate of copper and the zinc cells with acidulated water.

*From "Prescott's Electricity and the Electric Telegraph, (D. Appleton & Co.)

The Daniell Battery is scentless, and does not develop any poisonous vapors, and, hence, may be used anywhere without fear of endangering health or acting disadvantageously on the metallic parts of the surrounding apparatus.

It is especially adapted to telegraphic apparatus worked upon the closed circuit plan, but less suitable for open circuit, because in the latter case a good deal of metallic copper is formed at the bottom of the porous cups, by which the cups themselves become spoiled and the current is weakened.

The Siemens-Halske Battery.—The Siemens-Halske element, which is a modification of the Daniell, differs from the latter substantially in the improvements in the diaphragm. It is represented in fig. 7.

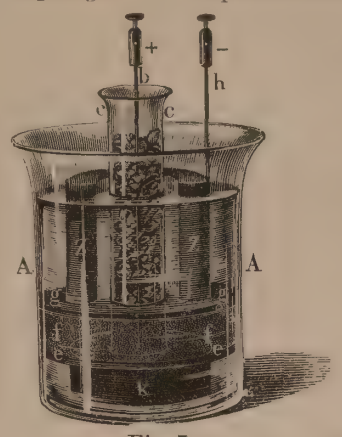


Fig. 7.

A A is a glass vessel, *c c* a glass tube, *k* a perpendicular copper plate bent into spirals, *b* a wire attached to it, *e e* a thin pasteboard disc, *f f* the diaphragm in place of the porous cell formed of a peculiarly prepared mass of paper, *Z Z* a zinc ring with clamp *h*. The mass of paper must be well compressed, and afterwards a fourth part of its weight of sulphuric acid poured over it and stirred up until the whole mass has become homogenous and glutinous. Then four times as much water is added to it, and worked with it; the superfluous sour water is removed under pressure.

The inner glass cylinder *c c* is filled with crystals of sulphate of copper and water poured on it, and the ring-shaped intermediate space filled with water, to which is added, on the first filling, some acid or common salt. Afterwards it is only necessary to keep the inner cylinder always filled with crystals of sulphate of copper, and now and then renew the water in the outside vessel. The sulphuric acid required to form the sulphate of zinc is conveyed by the current itself through the diaphragm, and simultaneously removed through it by the sulphuric acid which is set free by the decomposition of the sulphate of copper.

The cost of maintenance of this battery is very small, as all chemical consumption of zinc and copper is prevented in consequence of there being no local action. It may be left standing for months without impairing its action, if good care is taken that crystals of sulphate of copper are kept in the glass tube *c c*, and the diluted water replaced. The zinc is not amalgamated. In order to keep the foreign metals contained in the zinc separated from the mass of paper, the latter is covered by a ring, *g g*, of coarse cloth, which is replaced by a new one when the battery is cleaned, which ought to take place every fortnight. These elements have generally too much resistance for local batteries, but they are admirably adapted for working long lines.

The Meidinger Battery.—The Meidinger element is a modification of the Daniell battery, but has no porous cell, and possesses greater durability and constancy of current. It consists, as shown in the engraving (fig. 8), of a glass vessel, *A A*, 8 inches high and 5 inches wide, in the bottom of which is placed a small glass vessel, *d d*, of half the dimensions of the larger glass, cemented in with rosin. A zinc disk, *Z Z*, which is supported upon a ledge of the outside vessel, surrounds the smaller glass. The inside wall of the smaller glass, *d d*, is covered by a sheet of copper, *e*, on the lower end of which an insulated copper wire, *g*, is riveted. The mouth of the vessel is closed by a wooden or tin plate having an opening in the centre for the reception of a glass cylinder, *h*, 1½ inches in diameter and 8 inches high, narrowing towards the lower end, which is rounded, and in which a hole is made. This tube is sunk to the centre of the small glass, *d d*. The entire vessel is filled up to the zinc disk, about 1½ inches below the upper brim, with a diluted solution of Epsom salts. The glass cylinder, *h*, in place of which a glass funnel can be used, is filled with crystals of sulphate of copper, forming a concentrated solution, which, being a heavier fluid, sinks down through the small hole in the glass tube, and fills the small glass, *d d*, to the centre.

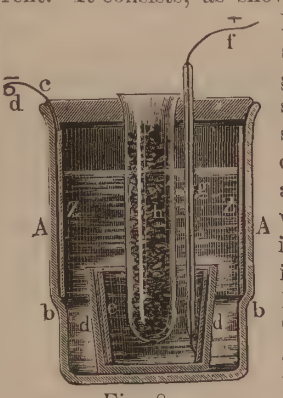


Fig. 8.

There is very little diffusion of the copper solution upwards, or out of the little glass vessel, *d d*, to the zinc disk, *Z*, even when the battery is not in operation; so that, after the lapse of several weeks, the zinc scarcely shows any signs of being affected by the copper. The battery is, therefore, much superior to the ordinary Daniell battery, which, when the circuit is open, produces a great diffusion of the sulphate of copper through the porous cup.

The Meidinger battery is valuable wherever long duration and a current of moderate but constant strength is required, and especially for operating the Morse telegraph, electrical clocks, hotel telegraphs and electric bells. The chief condition for its successful use is that it shall not be shaken, as shaking causes a mixture of the fluids, and in this way destroys its action and the constancy of the current. Its faults consist in the liability that the tube *h* may be filled up with sulphate of copper (either from impurities of the salt or from precipitation of metallic copper) or crystals of sulphate of zinc, so that the action of the element ceases; and partly because the flow of the solution of sulphate of copper from the tube to the lower edge of the zinc cylinder rises, and then, at the least diffusion, the sulphate of copper attacks the zinc. When this happens, the sulphate of copper is decomposed by the zinc, a superfluous quantity of sulphate of zinc is formed in the fluid, and metallic copper is precipitated in the form of a brown, spongy powder upon the zinc cylinder. This battery is extensively used upon the Austrian telegraph lines.

APOLOGY.—There were ordered, for this issue of THE POLYTECHNIC REVIEW, several attractive photo-engravings, refering to engineering articles, but continued rainy and cloudy weather prevented the photo-engravers from working, and, hence, we are compelled to issue a number not only meagerly illustrated, but lacking in engineering matter. We have an unusual number of engravings in preparation, and have made preparations to largely increase the quantity of illustrated matter.

THE MANUFACTURE OF ARTIFICIAL ICE.—THE PICTET SYSTEM.

The general use of ice for domestic, manufacturing and other purposes, dates from the early part of the present century; the immense extent to which this trade has grown, is well illustrated by the average consumption of New York and Brooklyn, which is about 300,000 tons per year, the yearly increase being estimated at about 70,000 tons.

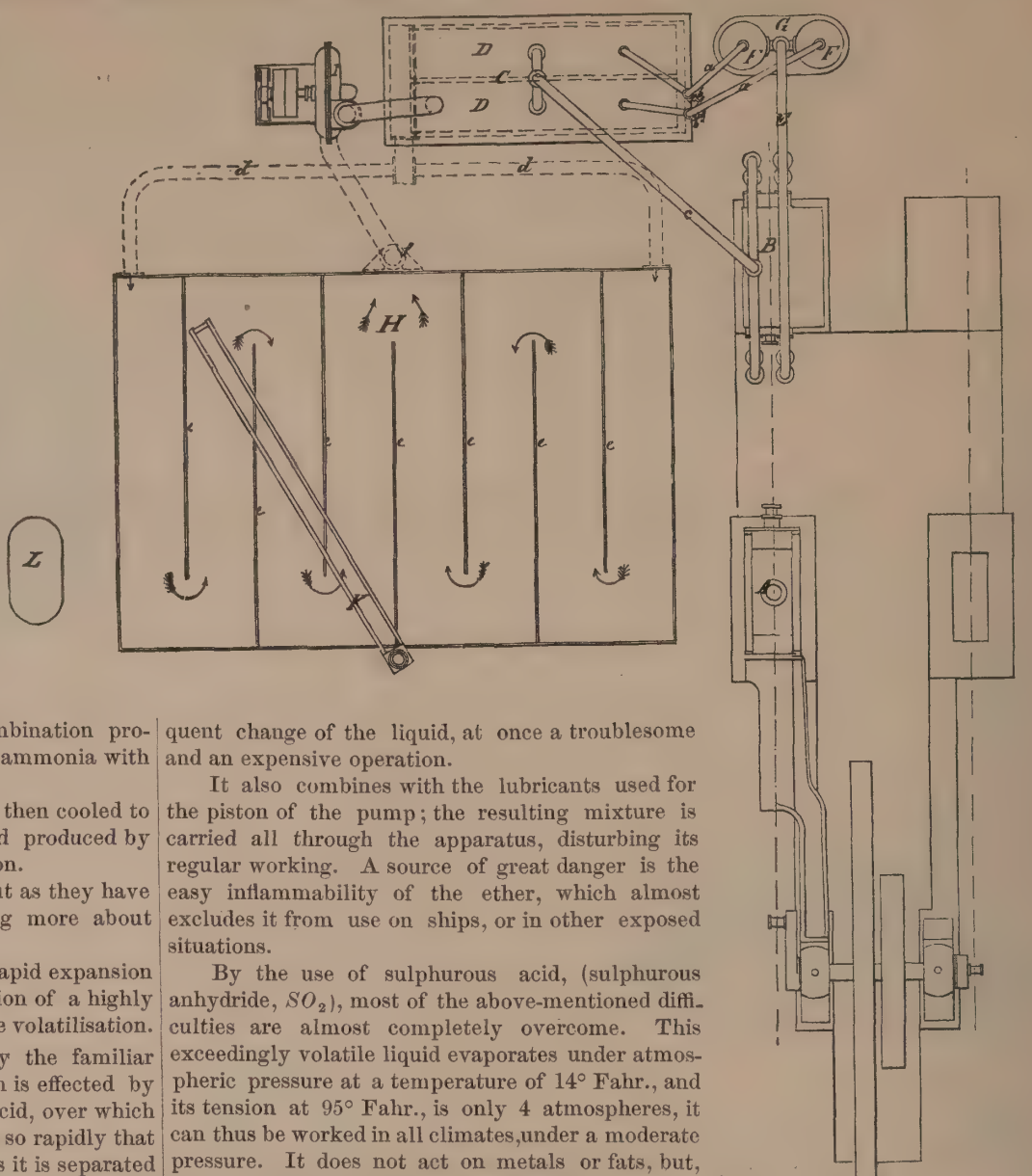
This increase is not so much due to domestic consumption, as to the requirements of manufacture, etc.

Brewers, soap and candle factories, etc., use immense quantities, and the transport of meat and fruit over long distances, that has recently been inaugurated, has created an additional demand.

In gathering natural ice for commerce, there are not only great expenses in cutting and storing it, erecting immense ice-houses, specially constructed for the purpose, and transporting it by rail or water to its place of consumption, etc.; but a great amount of waste takes place, which, even for a moderate climate like New York, is estimated at ⅓ of the crop. In Southern countries this waste is of course vastly increased, and this added to the greater cost of transportation, makes it an expensive luxury, although just there, it would be of so much more use and benefit.

These difficulties have caused numerous inventors to turn their attention towards the manufacture of ice by artificial means, and a great many different machines have been brought out.

The making of ice by freezing mixtures has long been known, and has found extensive application in the laboratory, and used also for freezing ice-cream, etc.



These mixtures are formed of certain bodies, whose chemical combination produces cold; such as salt and pounded ice or snow, nitrate or muriate of ammonia with water, nitrate of potassium, etc.

Elastic liquids, when compressed, are highly heated, and if they are then cooled to their former temperature, and permitted to expand, the amount of cold produced by rarefaction will be equal to the amount of heat generated by compression.

On this principle ice machines are worked with compressed air, but as they have not been a success to any extent, it is hardly neccessary to say anything more about them.

The most effective way to obtain a great amount of cold, is by the rapid expansion of a liquified gas when the pressure is removed from it, or the evaporation of a highly volatile liquid, especially when mechanical means are used to hasten the volatilisation.

What intense cold can be thus produced, is well illustrated by the familiar experiment of freezing water or mercury in a red-hot crucible; which is effected by the expansion of liquified sulphurous acid, or of solidified carbonic acid, over which ether has been poured. These substances, in evaporating, absorb heat so rapidly that even the red-hot crucible cannot supply it quickly enough,(especially as it is separated from the substances by their vapor, which is a bad conductor,) and thus the heat of the water or mercury is absorbed, causing them to freeze. The volatile liquids now mostly used in ice machines, are ammonia, sulphuric ether and sulphurous acid. Ammonia was first applied by Mr. Carré, who introduced a saturated solution of ammonia into a boiler, volatilising it under strong pressure, by heating it to 284°—302° Fahr. The vapor flows into a tubular condenser, washed by a current of water, which carries off the heat when the vapor is liquified by pressure. The liquid ammonia flows into the refrigerator, where it evaporates, producing intense cold; it is then conducted back to a vessel, where it is absorbed by water, and again goes through the same process. To liquify the ammonia, a pressure must be employed corresponding to the tension of the vapor at the temperature of the condenser. Now the temperature of the latter is dependent on, (and must of course always be somewhat higher than) the temperature of the water available for condensation.

The tension of the vapor is at

50°	6.5	atmospheres.
60°	7.7	"
70°	9.0	"
80°	10.5	"
90°	12·3	"

thus it is easily seen what immense pressures have to be used in warm countries.

Under such great tensions, the gas not only escapes through joints, but even penetrates cast-iron ¾ in. thick; the solution has thus to be constantly renewed, which is rather expensive. The danger of explosion also increases with the pressure, and accidents from this cause have often occurred. Another source of danger is the deposit in the boiler over the fire, causing the plates to burn, and finally leading to explosion, if not constantly watched. The ammonia machine needs a great many vessels, and an innumerable amount of pipes, coils, valves, &c., making it altogether a very costly and complicated affair. Somewhat simpler are the machines using sulphuric ether, which have lately come into prominence in England. The ether evaporates in a tubular refrigerator, imparting cold to an uncongealable liquid (brine) which circulates around and through it. This liquid is then introduced into a tank containing a great number of boxes, and freezes the water in the latter. The ether vapor is drawn up by a pump, which compresses it into a condenser, where its heat is abstracted by water circulating around it and through its tubes. The ether liquified by the combination of pressure and cooling, is then led by a small pipe back to the refrigerator, evaporates again, and is thus used over and over.

The small volatility of ether gives only insignificant tensions, the latter being from 1½ to 3 lb. (above zero), at 23° to 27° Fahr., so that a very large pump is required to draw up a certain quantity of ether vapor.

The first half of the process being conducted under almost a complete vacuum, the least leak in joints, stuffing, boxing, etc., will suck in air, which will seriously impair evaporation. After frequent evaporations and condensations, the ether becomes acidified, and is transformed into a less volatile isomeric body. This demands a frequent change of the liquid, at once a troublesome and an expensive operation.

It also combines with the lubricants used for the piston of the pump; the resulting mixture is carried all through the apparatus, disturbing its regular working. A source of great danger is the easy inflammability of the ether, which almost excludes it from use on ships, or in other exposed situations.

By the use of sulphurous acid, (sulphurous anhydride, SO_2), most of the above-mentioned difficulties are almost completely overcome. This exceedingly volatile liquid evaporates under atmospheric pressure at a temperature of 14° Fahr., and its tension at 95° Fahr., is only 4 atmospheres, it can thus be worked in all climates,under a moderate pressure. It does not act on metals or fats, but, on the contrary, forms an excellent lubricant for he piston, etc., of the compressing pump. It is not combustible, but on the contrary is an excellent fire extinguisher, which is of great value on board steamers, &c., and also being very stable and indecomposable,(if not in contact with water), a renewal is never necessary, except to supply the small quantities lost by leakage. The vacuum in the refrigerator is only from 2 to 3 lb. below the atmosphere, thus air will have no great tendency to enter, even should there be leaks.

Mr. Raoul Pictet, of Geneva, Switzerland, was the first to apply this liquid to the manufacture of ice, and the production of cold on a large scale; the process for its manufacture discovered by him, makes it the cheapest of all known volatile liquids.

The Pictet Artificial Ice Co. of New York, who are the owners of the patent for the United States, has erected a complete apparatus to manufacture 24 tons of ice per day.

The cut shows the entire arrangement, except the boilers, which are in an adjoining building.

A is a Corliss engine, driving, by a prolongation of its piston rod, the acid pump *B*, which is double acting. *C* is a rectangular iron tank, containing two cylindrical refrigerators of copper *D D*, which are filled with copper tubes. Inside these cylinders, in the space surrounding the tubes, the evaporation of the sulphurous acid takes place, and the cold produced thereby is imparted to the mixture of glycerine and water, which is then circulated in a way to be described further on.

Through the pipe *c*, the vapor is sucked into the pump *B*; on the return stroke it is compressed to about one-fourth of its volume, the pump being surrounded by water to absorb the heat generated by compression; the pump-rod is hollow, and has water circulating through it to keep it cool, and prevent damage to the stuffing-box packing.

When the vapor is compressed, it is forced through the pipe *E* into the cylindrical condensers *F F*, placed vertically in an upright iron tank *G*; the condensers are filled with tubes similar to the refrigerators, and cold water is pumped into the tank, circulating first through the tubes, and then around the cylinders, cooling the compressed vapor to about 65°, whereby liquefaction is attained. The small pipes *a*, *a*, reaching to very near the bottom of the condensers, conduct the liquid again to the refrigerator, the flow being regulated by the small valves *b b*.

On entering the refrigerators, the liquid evaporates, absorbing great quantities of heat, and thus it goes through the same process over and over again, each evaporation producing a certain quantity of cold.

The freezing liquid of glycerine and water is conducted by pipes *dd*, to a large tank *H*, into which the boxes, containing the water to be frozen, are immersed. The liquid enters at both ends of the tank, circulates around the partitions *ee*, as shown by the arrows, and finally is drawn out at *f* by the pump *I*, which returns it to the tank *C*, where, by circulating around and through the refrigerators *D D*, it is cooled,and then again resumes its flow through the freezing tank *H*.

The boxes containing the water to be converted into ice, are 12 by 6 inches, and 4 feet high; they are made of sheet iron, and after being folded together, are galvanized, which makes them absolutely tight, so that the water in them can never become con-

taminated by any impurities contained in the freezing liquid which surrounds them. The boxes, when immersed in the tank, are closed on top by a wooden cover, and the entire tank is covered by boards and woolen blankets, to prevent any radiation of the cold. An iron swing crane *K* sweeps over the entire tank, to facilitate the handling of the boxes; those that are frozen are taken out and put into the small tank *L*, containing hot water, and after a few minutes the block of ice is sufficiently loosened to drop out of the box, the ice is then stored away while the box is filled with fresh water, and goes back to the freezing tank. The ice produced by this machine is hard and clear, and is about 10 per cent. more enduring than natural ice, which has been frequently tried by putting a piece of natural and a piece of artificial ice of the same weight together on the floor, when the natural would be melted first. This seems probable, when it is considered that the freezing liquid is kept up at about 19° to 20°; a temperature a very little above that can thus be imparted to the ice, if left in the tank a sufficient time. Natural ice, however, its under side being always in contact with water of not less than 32°, will never be much below that temperature, although its top may be colder.

The smallest machine that is manufactured at present produces about 30 lbs. of ice per hour, while the largest has a capacity of one ton.

For breweries, these machines are of great value, and many have already been erected in hot climates where the brewing of beer formerly had been an impossibility. In this connection, it must also be considered that the erection and maintenance of costly ice houses can be dispensed with.

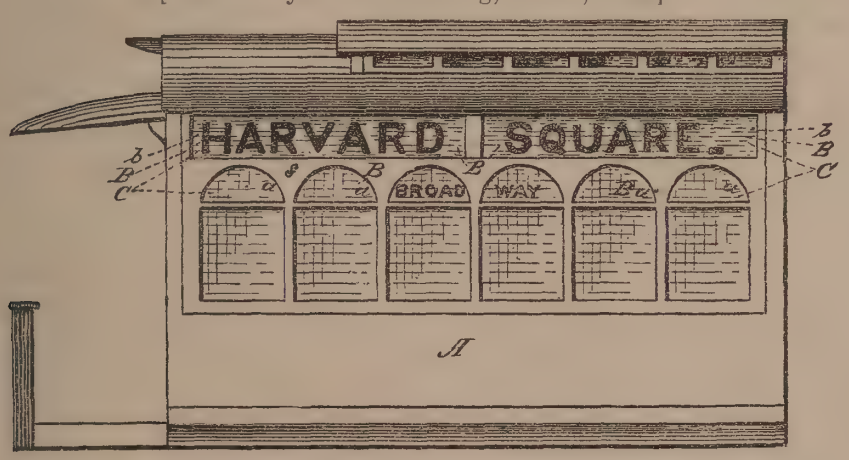
When the machines are to be used to produce cold air for cellars, warehouses, the holds of ships carrying meats, fruits, etc., the freezing liquid, after leaving the refrigerator, is circulated in a tank containing a number of pipe coils, through which the air to be cooled is forced by a blower.

For skating rinks this system has come into extensive use; those who are familiar with these agreeable and exhilerating resorts will certainly rejoice that this invention makes them independent of all the caprices of the weather, and enables them to enjoy the pleasure of the rink even on the hottest summer day. Skating floors now used in England,* the invention of Mr. John Gamgee, are formed of a number of flattened metallic tubes, placed side by side on a bed of concrete or asphalt. The interior of these tubes is kept filled with an uncongealable mixture of glycerine and water, which flows in from an elevated cistern, where it is cooled by machinery similar to that described above. The tubes are sprinkled with water spray, and after this is frozen, water is again sprinkled over it, until a smooth mirror of ice for skating is obtained.

As this invention is not yet fully developed, it is impossible to foretell what its capabilities are, and what impact it will give to progress in different manufactures and industries, but it seems destined to play an important part in the restoration of the commercial and industrial prosperity of this country. J. HAUG, M. E.

DESTINATION PLACARDS FOR PUBLIC CONVEYANCES.

[Patented by Albert A. Young, Boston, Mass.]



The patent herewith described relates to an improved method of exhibiting on public conveyances, such as cars and omnibuses, their destination and route in such a way that they will be visible by both day and night. The present system of conspicuously painting the destination, &c., upon the body of the car or "bus," would be all sufficient if their use was limited to day-traffic; since, however, this limitation does not exist, the necessity of a system of signaling which shall be visable at night is apparent. The provision of signals that shall not necessitate the use of additional lights is the object of the invention, which consists of destination or signal-panels, so arranged in the sides and end walls of the conveyance that they may be illuminated by the lamps as ordinarly arranged. The panels contain the destination of the car and, if required, its special route, in such a manner as to be visible both by day and night. The patent is likewise purposed to cover the construction of movable panels in the walls of cars or other conveyances, by means of which an open stenciled signal or destination panel can, for purposes of ventilation, be substituted in the summer season for the close panels of winter, and *vice versa*.

The side wall *A* of the car is so construeted as to provide at its upper part spaces for the reception of one or more panels. In the drawing, this space *B* is represented as forming, by means of the framing, two systems of spaces, but which is but one on the inside. One of these systems, *a*, is arranged immediately over the car-windows, and so arranged as to form arched continuations of the same; while the other or upper system consists of one or more rectangular spaces, *b*, lying immediately under the edge of the roof, which permits of larger and bolder letters on the panels, and enables them to be illuminated by the lights as ordinarily arranged in the car. The end windows of the car opposite the lamp, as well as the small window above the front door, can be provided with signal-panels.

The destination panels, so called, can be of metal or of wood, and can bear the signal, HARVARD SQUARE, as shown in drawing, and the route BROADWAY below, either in open stenciled letters for the summer, or the panel may be of glass, of two colors, with the letters ground through. In the winter, plain or tinted glass panels may be used in connection with the stenciled panels, in order to close the the openings.

It is apparent that either one of the two specimens of panels, *a b*, may be used, in which case the one panel must bear both the destination and the route. O. C. W.

*London and Manchester, and in construction in Liverpool.

THE MANUFACTURE OF COLORED PAPERS AND CARD BOARDS.

The items of colored papers and plain, colored and fancy cards, contribute no slight quota to the industrial statistics of our city and country; the annual products running into many thousands of tons and millions of pieces covering hundreds of square miles of surface.

Tracing the manufacture of the colored paper we commence with the colors, which are mineral pigments ground in size as in wall-paper making,* and distributed upon one side of long rolls of white paper by rollers and transversely vibrating brushes; the rolls hanging in looped folds which travel along a drying frame a hundred or more feet in length. This portion of the operation corresponds exactly with the "grounding" of wall paper. The long rolls are next cut into sheets, generally about 22 by 28 inches, which are pasted by hand upon sheets of coarse or fine card board, (according to the quality of goods required), on one or both sides as desired. Few cards are made throughout of colored pulp, or even colored directly upon the surface; it being cheaper to color paper and coat the card-board therewith. Machine pasters have been found to be less satisfactory than hand, except for roll work. Paper, called "tea" paper, and cover paper, used in the cover of THE POLYTECHNIC REVIEW, cannot be made as brilliant as when the same amount of pigment is applied to the surface of white or uncolored paper. Card-board is usually made in sheets, because long rolls would be much too heavy to handle and use. Card-boards are made of two or more thicknesses of paper pasted together and covered with the surface paper. The sheets of covered card-board are next made into piles, and pressed with a powerful hydraulic or screw press, and then are passed several times between smooth metal rollers, the comparatively dead surface of the pigment being smoothed or glazed by the passage. The sheets are next ready to be cut to size—circular adjustable knives set at proper distances upon rollers between which the sheets are passed, cut them into strips; and shearing knives cut these strips into cards of the required size, which are then boxed or bundled in gross packages.

Railroad tickets, which generally have an unglossed surface, with stripes differing in color, number, width and direction, are made from sheets which have been striped by flannel rollers saturated with suitable coloring fluid. The counting is much facilitated by each strip of a sheet going into a separate compartment; thus 100 sheets give a certain number of piles, each containing 100 strips; each 100 of the strips cuts up into a given number of "100" piles of cards or tickets.

Photographers' mounting cards have their backs ornamented with lithographic patterns in the sheets; the monogram of the artist may be printed on either at the same time with the ground-work, or in sheets after the ground-work on the separated cards, according to the size of the order. The corners of most of these cards are cut rounding by dies.

While there are several standard sizes of printers' cards, there is an innumerable number of odd sizes which must be made to order; and there is an infinite variety of thicknesses, qualities, colors, tints, all to be ordered by sample, number or letter. The stock to be carried is an unusually heavy one, both as regards its money value and its weight, and the floors of a card factory have to be unusually strong and well supported. (The heaviest floor stock to carry is iron pipe or lead.) Messrs. A. M. Collins, Son & Co., Third and Canal Sts., Philadelphia, whose establishment we recently visited to inspect and report upon the automatic stoker there in successful operation, require a capital of about $300,000; consuming about 1,500 tons of card and paper; employing 200 hands, (men, boys and girls.) The railroad tickets are ordered in quantities of 20,000 to 1,500,000 at a time. There is very little waste in making up stock, the paper makers getting but a very small proportion of trimmings to be worked up. G.

THE HYDRAULIC AS COMPARED WITH OTHER JACKS.

Of all the numerous forms in which jacks are made, there are none as complete in every respect as the hydraulic. The principle is that of the ordinary hydraulic press, which uses differential areas to do the work, the liquid performing the function of transmission of power from the plunger to the ram. These jacks are self contained, and are not so likely to receive damage by rough usage as are other forms; all the attention necessary is that they be supplied with oil or whisky, from time to time, to make up for waste in the chamber.

The working parts all coming into contact with the oil, or whisky and oil, are abundantly lubricated, they consequently work easier, and are not likely to stick and cut. As regards the economical utilization of power, they are superior to all others, (of course not considering quick lifts, such as wagon jacks, &c.), the greater part of the friction is produced by the circulation of the oil, that on the running parts being slight, from the little motion necessary to the operation of the machine. These jacks are light and portable, up to 15 tons capacity, can be carried by one man. They can be placed in any desired position, often where, from size and space required to work them, no other can be used. There is generally a lug or foot projecting from the lower end of the sleeve, which is meant to take hold near the ground, where there is insufficient room to place the head for lifting. The handle is the only detachable piece, but for convenience in carrying, it is better taken off.

The screw jack, it will be readily seen, is subjected to great friction from the contact of the threads, and, as is often the case, insufficiently lubricated, especially in cold weather, when the oil is chilled; and only when a workman gets out of patience with the stiffness of his machine, is it oiled at all. This inattention causes the jack to wear out faster than it should, and produces loss of effect from the amount of power applied.

The kind operated by rack and pinion, although used extensively, is not good; as it is easily deranged and dangerous to use, because if the pawl slip when the strain is on it, the handles may do serious injury to the workman.

The ratchet-jack has more or less objectionable points, one of which is the use of teeth at all, where the machine is subjected to great strain.

There are none which occupy so small a space and are so efficient as the hydraulic.

These have no projections to be broken and bent out of shape, and to injure the operator. The body is made of hydraulic tubing, and will support an enormous

*See article in THE POLYTECHNIC REVIEW, iii, 229.

crushing strain. A great advantage of the hydraulic over the screw jack is, that the operation of the former is continuous, while the latter (except when a ratchet is attached) requiresthe wrench to be placed anew every time the stroke is made.

The lever of the hydraulic jack is generally in the most advantageous position for a man to use his strength; and by simply reversing its position on the rock-shaft, a lug on the side engages with the valve trip, which opens communication between the reservoir and the cylinder of the ram, so that the operator can lower the weight at will, and check it at any desired point. But the screw and rack require the same number of turns to lower as to elevate the weight.

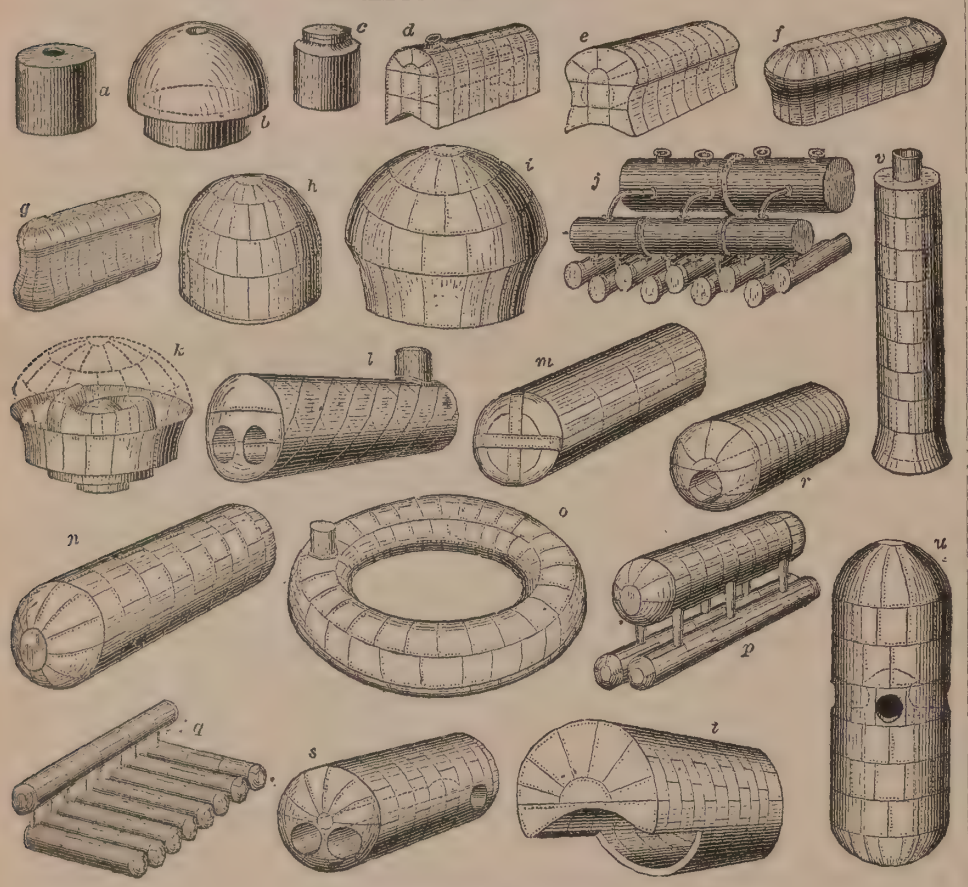
By the ordinary method of lifting heavy objects, using pries, a large force of help is required, and time is lost in changing the fulcrum. But by employment of the hydraulic jack, these difficulties are obviated, and one person can lift, with comparative ease, as much as 120 tons; while it would take a number of men to do the same work in equal time by the ordinary way.

The uses of this jack are numerous; sometimes in making alterations in buildings they come into play for raising even brick walls, till the temporary timber supports are placed in position. They are used for repairing bridges and in their construction, also in locomotive and railroad shops for all heavy lifting.

But they are applied most extensively to the raising of heavy machinery, castings, engines, boilers, &c., for which purposes they are almost indispensable.

As machine-shops are likely to be equipped with them, it is well to have a frame, constructed of two rods attached to a cross-piece, and having another piece adjustable by means of holes in the rods to receive keys. The jack may be placed in this and used for all purposes for which a press is available; thus saving time, where, in some cases, the forcing would be done with a sledge, bruising the work from carelessness, and causing great waste of time. E. P. T.

[Mr. Dudgeon, the original inventor of the hydraulic jack and punches has, within the last few years, made considerable improvement in the interior arrangement of the jack, which makes them even more desirable than ever.—EDS. REVIEW.]



FORMS OF BOILERS.

The accompanying illustration shows some of the forms of steam boilers, both of the past and present, as taken from the report of Mr. Marten, of the Midland Steam-Boiler Inspection and Assurance Company of England:

a was the *Savery* boiler.

b, the *tun* boiler.

c, the *flange* boiler.

d, *e*, *f* and *g*, are forms of the *wagon* boiler.

h, haystack boiler.

i, balloon boiler.

j, a boiler of nine cast-iron pipes, a transverse larger connecting pipe, and an upper one forming a steam dome.

k, an improved *haystack* boiler, with a central dome-like fire-place and helical flue.

l, *cylinder* boiler with flues and boiler-plate head.

m, *cylinder* boiler with cast head banded.

n, *cylinder* boiler with hemispherical ends.

o, *ring* boiler.

p, the *elephant* or French boiler.

q, the *retort* boiler.

r, the *cylinder* boiler with single flue.

s, the *cylinder* boiler with two flues opening at the front and at the sides, near the rear end.

t, the *butterfly* boiler, fired internally, and uniting the *cylindrical* and *wagon* forms.

u, *upright* boiler with hemispherical ends.

v, *chimney* boiler.

The cut is Levytyped from "Knight."

DISINFECTION BY CHLORIDE OF LIME.

In a previous article it was indicated that the processes of putrefaction could be effectually counteracted by the proper use of substances which act destructively upon the lower forms of life, to the generation and growth of which, putrefaction and decay are directly traceable. A brief consideration of the most important of this class of substances, which are generally called disinfectants, will be found useful.

The most commonly-employed of these is doubtless chloride of lime. Considered chemically, it is a mixture of hypochlorite of lime, chloride of calcium, carbonate of lime, and traces of caustic lime. The disinfecting qualities of this substance depend entirely upon the presence of the hypochlorite, an unstable compound, which, when it is brought into contact with an acid, liberates a generous supply of free chlorine, a gas which appears to effectively check the putrefactive process, and acts destructively upon the germs which are the causes of infectious diseases. It is in many instances unnecessary to assist the liberation of chlorine, by the addition of an acid, since even the influence of the carbonic acid of the atmosphere, suffices to effect a slight but continuous evolution of this gas. The quantity of chlorine that may be obtained from a given weight of chloride of lime, is governed, as before remarked, by the percentage of hypochlorite which the sample contains, and this may vary considerably, according to the excellence of the product; hence the estimation by analysis of the quantity of available chlorine in a sample of chloride employed is often a matter of importance.

The gaseous nature of the disinfecting substance in this instance. and its very energetic action, renders the chloride of lime of admirable service in the purification of apartments, occupied by those who have been afflicted with infectious diseases; the floors and walls of hospitals, the beds and clothing of the sick, &c., &c., for which purpose the addition of a free acid is to be recommended. On the other hand, the addition of the chloride of lime to large accumulations of refuse matters is generally of little value; for the reason that to be efficacious, enormous quantities of the disinfectant must be employed. And this addition is not only objeetionable *per se*, but it will in most cases render the entire mass worthless, thus preventing the subsequent utilization of the refuse. The application of chloride of lime to the purification of cesspools is, on these grounds, not advisable, as will appear from the following considerations: The accumulation of fecal matters, mixed with urine, rapidly manifest a decided alkaline character, as is clearly manifested by the powerful odor of ammonia which pervades the neighborhood wherever such accumulations have been left even for a short time undisturbed. When chloride of lime is brought into such a mixture, the conditions for the liberation of chlorine are not present, and even where we may suppose that considerable acid has been added to the disinfectant, this will be seized upon by the free ammonia present; while the great excess of oxidizable substance present, will speedily deprive the hypochlorite of all its oxygen, and leave us instead of chloride of lime, the chloride of calcium—a substance having no disinfecting properties. These facts are important to be remembered, since one is occasionally called upon to apply a remedy for a nuisance that has become intolerable, and may readily commit the error of supposing that the disinfection can be accomplished equally well with one as with another corrective. It will be well, therefore, to bear in mind that the chloride is not a panacea for such ills as we are here considering. Where the substance to be disinfected is small in quantity, the hygienic action of this disinfectant is rapid and effectual; but where large accumulations of refuse matters are to be treated, the use of the chloride of lime is attended with grave objections, to-wit:—The addition of even a small quantity of this compound to animal refuse, will suffice to render it quite useless for fertilizing purposes, since it has been ascertained that the chloride of calcium, which is formed as the resultant product of the decomposition of the chloride of lime, exercises a positively injurious action upon vegetation. Aside from this, if a considerable quantity of free acid is added to the disinfectant to assist its action, such addition, before it can be neutralized by the free alkali present, may act very injuriously upon the materials of which the well is composed, and cause serious damage, if often repeated.

To sum up, therefore, we may repeat that for the fumigation of the wards of hospitals, sick rooms, bedding, clothing, and the like, the chloride is effective and admirable; for disinfecting large masses of refuse, on the contrary, it will be expensive from the great quantity of disinfectant required; it would not accomplish the work effectually unless often repeated; the value of the product for agricultural uses will be quite destroyed, and the addition of large quantities of acid, necessary to bring out its disinfecting qualities, may act so injuriously on the materials of the well as to affect its virtues. It is not, therefore, to be recommended for this purpose.

We shall consider in another article several other well-known disinfecting agents, and endeavor to explain their properties, and the best methods of using them.

W.

OUR NEW DRESS.

The present issue of THE POLYTECHNIC REVIEW appears in a new dress throughout, and, as we write these few lines, we hope for a very creditable appearance. Of course the delays and annoyances incident upon the laying and sorting of large fonts of new type, with their innumerable special orders of accents, Greek and other characters, and the cutting of leads and rules, re-setting advertisements, etc., may somewhat delay the publication; but we have every reason to believe that with new type, and paper, and presses, we shall satisfy our subscribers.

Our *Subscription Department* has been reorganized under the experienced management of Mr. JOHN M. HOLLAND, who designs, and has arranged a system of circulation which will effect a complete and thorough introduction of the REVIEW throughout the *United States*, *Canada*, *Europe* and *South America*, and thus secure for it a subscription list which will equal, if not surpass, that of any other scientific periodical published in America; and we feel assured that the able character and standard excellence of the journal will unquestionably enable him to accomplish this purpose.

THE DIVISION OF LABOR AND SOME OF ITS EFFECTS.

In no trade has the division of labor produced greater effects and more economy of both money and labor than in that of the working machinist. So great, indeed, is the change that it is difficult to define the line of demarkation between what is in reality skilled and unskilled labor. Were we to accept the old standards of demarkation we should be called upon to reject as skilled labor a large proportion of mechanics producing by the aid of machinery work that formerly necessitated the employment of the most skillful of workmen, while, on the other hand, we should be required to classify as skilled labor a class of men altogether unknown within the memory of a majority of our old workmen.

Let us take, for example, such an establishment as Darling, Brown & Sharpe's. Here we shall find all classes of work being done, from the finest of tools, gauges and sewing machines to large grinding and milling machines. Such an establishment in the olden days would have been managed by a general superintendent, general foreman, foreman of turners, foreman of fitters, or vise hands, and foreman of erectors, as those who assemble and put the machines together would have been called. The apprentices would have been, if such a shop were in England, put first to the lathe for three years, then three years at the vise, and one year at erecting, while in the United States they would probably have been put to the lathe or vise only, or, on rare occasion, to both. In selecting, when occasion required, a foreman, the most expert workman in the required branch would be sought, no matter what his education or knowledge outside of his manipulative capacity might or might not be. A general as well as detail drawings of every part of a machine would be supplied to him, the designing being left entirely to the drawing-room.

Workmen operating drilling machines, screwing machines, tapping machines, and, in many cases, planing and slotting machines, were not exactly termed skilled labor, because, while the experienced gained at the lathe was supposed to render a turner naturally capable of operating skillfully either of those machines, while an operator of either of them was not supposed to be able to operate a lathe, and in this there is a great deal of truth.

Under this regime the whole aim of the ambitious workman was to become skillful with his tools in the beaten path of the then universally accepted methods of manipulation. The success of a business then depended entirely upon the skillfulness of the workmen, but we have changed all that, so that the best thinker has routed the most skillful workman, and the result of brainwork is gradually, in small work at least, dispensing with great manipulative expertness altogether. That this is so is not entirely due to the absolute superiority of modern processes, but, in a great measure, to the difficulty of obtaing a large quantity of very skillful manual labor, and this is the reason that the division of labor and the employment of special machinery has taken such a firm hold of the American mechanical mind. The world has never given the skillful mechanic his proper position; it has assumed that skillfulness lay in mechanical movements performed by the hand, whereas, such is anything but the case. In manipulating a piece of work by hand to the *best* advantage, the perception and judgment, as well as the senses of sight-feeling and finger-expertness, are constantly drawn upon in a manner so minute and technical that but few of the most skillful workmen can explain the secret of their skill.

The old workman's business was to do his work well and expeditiously, and for quality, and upon large work, in a great measure, for quantity also, he still holds his own. Indeed, where great exactitude is necessary, all efforts have failed to supersede the use of hand-work and hand-tools—witness the scraper grinding lap, etc. The tendency of modern times, however, is to devote the thought and study, formerly directed to becoming manipulatively expert, to the production of special tools and appliances that shall take the place of hand-skill aid; to this end it has been attended with a surprising degree of success, producing a large amount of excellent work in reduced time and with less expense. This system, however, has its drawbacks, and some of these it may be well to point out, premising our remarks by noting that it has been, and will continue to be, on the whole, a great benefit to the world, and is undoubtedly destined to increase.

All manipulative operations that require so many qualifications to become a complete master of, as does that of the skillful machinist, it is a benefit to dispense with as far as possible; providing that care is taken to preserve in all cases the highest standard of quality attainable under the old dispensation. For example, if out of fifty workmen we find one who is vastly more expert than his fellows, we are not, as has been the custom, to put it down to a lacking of the forty-nine, but rather to extraordinary qualifications possessed by the one; and our endeavors should be directed to surpass by special machinery the production, so far as quantity and uniformity of gauge is concerned, of the most skillful. But to preserve at the same time the superiority of the one as to quality, for it may be accepted as incontrovertible that when it becomes a mere question of quality, hand labor cannot be equalled. These remarks occur to us because of signs which appear to us at intervals, denoting that in many cases the hand labor performed upon a piece of machinery is not up to the olden standard. We have before us, for example, a delicate little instrument, beautifully gotten up, excepting where the hand-finishing has been done, and there the edges are not square, the surface is wavy, and the standard anything but up to that of the general instrument. But a short time ago we were shocked to read a regulation issued by the Master Car-Builder's Association, forbidding the centre-punching of the wheel seats to make them fit upon the axles, and we were led to ask ourselves, Can such things be? 'Nor need one after that be surprised to read a regulation forbidding the use of glue in place of car couplings.

To maintain the quality of hand skill, however, is a difficult problem under the division of labor and special tool and machine system, because the number of hand-skilled workmen is so greatly reduced. How, for example, is a shop to possess a hand-skilled mechanic equal to the best out of fifty, when there are not fifty hand-working mechanics in the shop. In such a shop as we have mentioned in the earlier part of this article, we shall find a large majority of the men working upon special tools and machines, which require but ordinary care to work, and upon which skillfulness can only be exhibited in moving the various handles and levers with celerity, or in other words, industry rather than expertness tells. The foremen are skillful in watching that the tools are kept in order, the men supplied with work, the work kept to gauge, etc., rather than being themselves skillful operators. Then again, promotion is sought and obtained in and by making improvement in the tools, machines, &c., and furthermore, we shall find a class of workman whose whole aim and study is the improvement of special machines, tools, appliances, etc., designed to expedite or facilitate the manipulation. These are the men who progress; they are indeed valuable mechanics, but the fact remains that they are not practically hand-skilled, and the result is that in many of their productions this is painfully apparent to the hand expert, who, while perceiving that he is distanced in the race for quantity and uniformity of size, yet detects errors in the shapes of tools, rates of cutting, speeds and feeds, etc., etc., and feels that the system is lacking in that respect. In the tool room we may find expert hand-working mechanics, so far as their experience goes; but the continued operation of making tools for others to use is not calculated to give the large experience necessary to teach one what is the exact best shape to make a tool, while the workman who has never used tools of any other shape, knows nothing of the comparative merits of different shapes and degrees of temper, nor has he any conception of what a great difference an almost imperceptible variation in the shape of a tool will make. When such men are brought face to face with some of the results obtained by hand-labor, they regard it as something extraordinary and not commonly attainable, and appear to have no conception of what can be done with hand tools, operated by those taught how to properly use them.

The result of this state of affairs is apparent in another way, inasmuch as we are continually traveling in a direction in which, while improving the machinery to cheapen production, we are getting less work from the *cutting tools* themselves. How many, for example, firmly believe that one man can run two small lathes to advantage; whereas, the fact is, that upon ordinary work it will take him all his time, if he uses one such lathe to its utmost capacity, unless, indeed, his work requires long parallel cuts, and this is the exception rather than the rule. If we watch an expert lathe workman upon small work, we shall find that he very rarely uses the self-acting feed motion, because it is altogether too slow for him; and furthermore, upon short work he will wind the cut up by hand in less time than it takes to put the lathe-feed in and out of motion.

It is out of all question to educate hand labor sufficiently to give it any chance of success in competition with special tools; but it is at the same time utterly impossible to learn the very best shape and temper for a tool or for tools, unless one has had sufficient experience in making, using and comparing the results from them to enable him to understand the subject thoroughly and intuitively. "It did me good, said a workman to us the other day, "to see the speed of the shaping machines at the Providence Tool Co.'s shops; it put me in mind of old times." Our technical schools can do much for us in this matter by giving the students a knowledge, at least of the capabilities, of the hand tools; the effects, indeed, of the Cornell University and Worcester Free School exhibits at the Centennial, in this direction, were excellent, for hundreds of mechanics there saw for the first time what good scraping really was, and circular polishing or scrubbing with energy became less easily palmed off as scraping, or as an evidence of fine workmanship.

JOSHUA ROSE.

JOWETT'S PATENT SMOKELESS FURNACE.

This furnace, with smoke burner, is rapidly coming into use for marine boilers, and is found in practice to effect perfect combustion, with great economy of fuel. In using this furnace, the stoker when opening the door to put on fresh fuel, imparts motion to the crank, which brings the rod and link forward, and throws over the mercurial wheel, thus reversing the position of the air door. The firing finished, the stoker closes the firing door, leaving the air door wide open, and the mercurial wheel in a position to complete its perfect closing, which can be done in any given time, dependent on the quantity of the unconsumed products coming over from the fire. When the gaseous products of the incomplete combustion are coming over the bridges, unless they are consumed, smoke will be the result, because the hydro-carbon gases are escaping without the proper combination with oxygen; the object of this invention is therefore two-fold, first, to supply the necessary quantity of oxygen by means of the air door, and second, to restore sufficient heat to these imflammable gases, to convert them into heat generators; which latter function is performed by the combustion arch. This arch being constructed of fire-bricks and clay, retains the heat constantly passing from the fire, and when the gases which have not been consumed come in contact with it (after a new fire) the air door supplies the necessary oxygen, which mingling with the gases impinge on this arch, and cause ignition; or in other words, complete the combustion, which before was incomplete. The result is greater heat in the tubes and flues beyond the bridge, and no smoke. The continuous admission of air beyond the bridge is detrimental to the generation of steam, because by the continued influx of air the flues become cool, and the benefits previously derived from the perfected combustion are nullified. Jowett's patent apparatus, however, is specially designed to prevent this, for it only allows the flow of air for a certain time, (and that the requisite one), when by its automatic action the mercurial wheel closes the aperture, preventing the admission of air, which would otherwise become detrimental. This invention can be applied with equal advantage to any ordinary land boilers; it can be put into internally fired boilers, or under any that are fired externally, and in every case these smoke burners are found to be perfect preventors of smoke. Mr. James Jowett, of the Whitehall Works, Leeds, is the sole manufacturer of this furnace; and he claims for it that when the firing is hard, the utility of the invention, as to economy, is more marked, while for any boiler hard pressed the invention is invaluable.—*Coal Trade Journal.*

MACHINE KINEMATICS.

We take pleasure in announcing that a former pupil of Prof. Reuleaux, at the Gewerbe Academie, in Berlin, is preparing for us a series of illustrated articles bearing upon this new and important science, which is destined to do so much towards the simplification and proper comprehension of machinery. The first article will treat in a general way of the principles of the kinematics of machinery, (analysis, rotation, etc.), the second, of crank mechanisms; the third, of rotary engines; the fourth, of "pressure and tension organs."

The necessary engravings are now being prepared; and we shall take great pride in being the first journal (perhaps the first medium) in this country to disseminate the principles elucidated by Reuleaux, and but recently put before the British public by Prof. A. W. Kennedy.

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SLIDE VALVE GEARS.

BY HUGO BILGRIM, M. E.

SECOND PART—III.

THE VALVE DIAGRAM.

According to the foregoing the movement of the valve of the Stephenson link motion can be supposed to be derived from a series of eccentrics, and hence the distribution of the steam can be studied by a series of valve diagrams. To find them we perform the double operation of rotating the diagram of ideal eccentrics ($I'i^\circ I''$) through 90° and inverting it. This transfer or conversion can, in fact, most readily be accomplished by means of a piece of tracing paper, *i. e.*, by tracing this diagram, reversing the paper and turning it to bring the previously vertical line in a horizontal position. Thus we obtain the curve $Q'\,q^\circ\,Q''$ (Fig. 34) on which the centres of the lap circles of the required valve diagrams will be located.

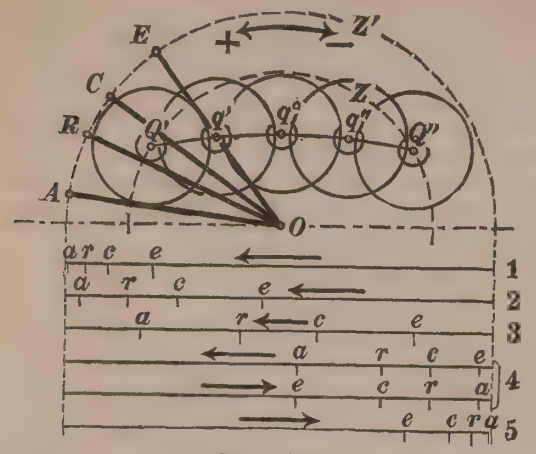


Fig. 34.

The investigation of five different grades will fully suffice for a clear understanding of the operation of the link and the study of more intermediate grades will offer no difficulty. We shall choose for this purpose the lowest position of the link and every following grade produced by successively raising the link one-quarter of its length, ending with the link in its highest position. The corresponding centres of the valve diagram (Fig. 34) are Q', q', q°, q'' and Q''. Both lap circles can now be swept from each of these points, and we obtain for the first grade, forward, the crank angles OE, OC, OR and OA for expansion, cushioning, release and admission of steam. After drawing the crank circle Z', to reduced scale, we can find the corresponding positions of the piston, e, c, r and a on the line 1, by projecting the points E, C, R and A. The positions of the piston for the corresponding stages of the steam distribution of the other grades can be located in the same manner, and are marked on the lines 2, 3, etc. The crank-lines necessary for their construction are, however, omitted in Fig. 34, to avoid confusion. At all these grades the steam is omitted, on the steam side, until the piston arrives at e, it expands between e and r, and is exhausted for the rest of the stroke. The exhaust side of the cylinder is in communication with the exhaust passage before arriving at c, where cushioning begins, and at a the port is opened again and steam is admitted for the following stroke.

Now, it will be seen that at grade 2, expansion, compression, release and admission take place earlier than at the first grade, showing that the link furnishes means for varying the degree of the cut-off. The action of the valve at the mid-gear, or grade 3, is remarkably symmetrical as regards both ends of the cylinder. Expansion, compression and release begin at very early stages

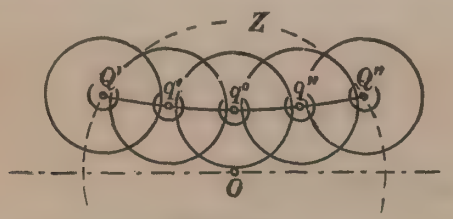


Fig. 35.

of the stroke, and the admission of steam for the following stroke, at a, takes place at such an early time that the piston has to force the admitted steam back into the boiler to complete its stroke. This action will last as long as the admission of steam at the beginning of the stroke, and the work then developed will be entirely consumed. Steam is exhausted on the exhaust side of the cylinder from the beginning of the stroke up to c, where cushioning begins, while on the other side steam is exhausted after the piston passes the point r. The steam expands while the piston moves from e to r, and the exhaust steam is compressed between c and a, which are again at equal distances, but as the mean pressure of the expanding steam generally exceeds the mean pressure at compression, there is a slight gain of work, which, however, is rarely sufficient to run the engine when without any load. This singular process is the same whether the crank-shaft rotates in the one or in the other direction. By reason of these facts the centre of the link is called, very properly, the "dead point of the link."

Passing over to grade 4 we find the action of the valve to be hastened still more, (see upper line.) The steam is now admitted on the exhaust side (after the piston passes the point a) for a considerable longer period than on the steam side, (before the piston passes the point e); hence the motion of the crankshaft will be retarded—the admitted steam tends to rotate the shaft *backward*. At this grade the link is indeed raised so far that the backward eccentric I'' exerts a predominating influence upon the valve, and we might have arrived at the above conclusion without the diagram. The distribution of steam will, therefore, take place as shown by the lower line. However, the upper line, (grade 4) shows the process when a running engine is suddenly reversed. The engine will act like a pump, forcing air from the exhaust passage into the boiler until a stoppage and reversal of the rotation is effected. But as most locomotives exhaust into the smoke-stack, the air which is thus pumped into the boiler contains ashes in suspension which is apt to precipitate on the walls of the cylinder. It is, therefore, very injurious for the engine to reverse in this way, unless provision is made to cut off the communication of the exhaust-passage with the smoke-stack.

The line V (Fig. 34) shows the action of the valve when the link is fully reversed.

As regards the lead, the behavior of the Stephenson link-motion is very peculiar. The lead being represented by the distance of the lap-circle from the horizontal centre-line, the diagram (Fig. 34) indicates that the lead is variable at the different grades. It is greatest at the intermediate grades and least at the full-stroke grades. It will further be seen that the lead at the mid-gear is equal to the greatest port opening of the same grade, the valve being at the end of its travel when the crank is on its centre. The greatest port opening is found to be greatest at the full-stroke grades and least at mid-gear.

In Fig. 35 is shown the valve diagram of a link-motion with crossed rods. We find in this case the behavior, relating to the lead, reversed, as compared with (Fig. 34), and besides the greatest port openings for intermediate grades decidedly smaller. This latter is the principal reason why crossed rods are seldom in use.

THE LINK AND ITS SUSPENSION.

The slot of the link should be curved in such a way that the "centre of movement" or "neutral position" of the valve should be the same for any grade of the link. Hence, if we transfer the ends of the eccentric rods to the centre O (Fig. 36) of the crank, shaft a lowering or raising of the link should not affect the valve. This condition is fulfilled when the curvature of the link (in the position shown in Fig. 36) is a circular arc swept from the centre O of the crank-shaft. Both eccentric rods should, therefore, be of equal length, and the radius of the centre line of the slot equal to the length of the eccentric rod plus the distance of the pin-hole P (Fig. 25) from the centre line of the slot. If the link is as shown in Fig. 26, the latter distance is = zero.

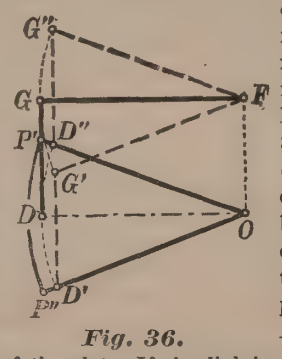


Fig. 36.

The link should be made neither too long nor too short. A definite rule cannot be given to comply with the different conditions to which link motions may have to be adapted. Good results may be obtained, in most cases, by making the available length of the slot of the link about six times the throw (OI') of the eccentrics. The actual length, of course, must be longer by something more than the height of the link-block.

The mode of suspension of the link has a decided influence upon the regularity of the action of the link-motion. In our investigation we assumed that every point of the link were moving in a horizontal line. To approach this supposition as near as possible, the suspension rod GD (Fig. 36) should be made as long as space and convenience will permit, in order to flatten the arc in which the point D moves. Besides, to keep this arc in a horizontal position, the neutral position of the rod GD should invariably be vertical, whether the link be raised or lowered, and this will be the case if the upper point G of that rod is guided in an arc $G'\,G''$, which is equal to the arc $D'\,D''$, in which the pin D of the link is moving as the link, in its neutral position, is lowered and raised. The centre F of the suspension lever should, therefore, be vertically above O, at a distance equal to the length of the hanger GD, while its length, FG, should be equal to the distance OD in Fig. 36.

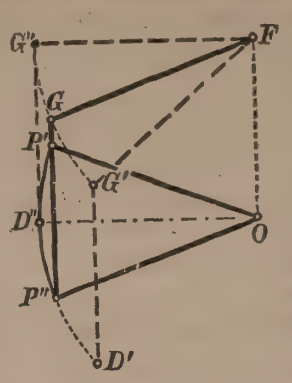


Fig. 37.

If the link is suspended by the lower pin P'', Fig. 37 will have to be substituted for Fig. 36, in the above demonstration.

In practice, the length of the suspension lever, FG, is seldom made of the length required by this rule, sometimes for want of space, at other times on account of the inconvenience of such an extreme length. Besides, it is a general practice to purposely introduce certain irregularities by the mode of suspending the link, to compensate for the unequality between fore and return stroke, caused by the angularity of the connecting rod. This matter will be discussed later.

EQUALIZATION OF THE LEAD.

We have seen that the lead of the Stephenson link motion is variable with the different grades, and this is regarded by some engineers as a disadvantage of this valve gear. It is, however, questionable if this objection is really worth much attention. We shall, therefore, but briefly discuss the method that is sometimes employed to equalize the lead.

The said variation of the lead is owing to the change of the inclination of the eccentric rods in changing the grade, and will, therefore, be reduced by the use of long eccentric rods and a comparatively short link. It can be traced back to the variation of the locus $I'i^\circ I'$ (Fig. 29) from a vertical line.

The method alluded to consists in giving to the forward eccentric I' a greater angle of advance than to the backward eccentric I'', (Fig. 38), when the locus of ideal eccentrics will be found as before, the result being the arc $I'i^\circ I''$. The lower half of this curve now approaches more nearly a vertical line, (compare Fig. 38 with Fig. 29), showing that the lead will be less variable at the different forward grades, and this variation is least if the point i° is vertically above I'. The upper half of the locus in Fig. 38, however, deviates considerably more from a vertical line than before, hence the equalization of the lead for the forward grades is accomplished at the expense of the lead of the backward grades.

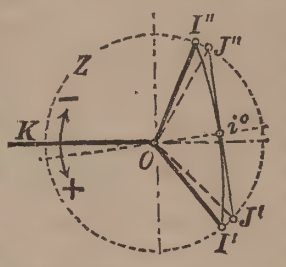


Fig. 38.

A link-motion with equal angles of advance can be changed to have equalized lead at the forward grades by advancing both eccentrics through a certain angle, in the direction of the forward rotation of the shaft, or else by moving the crank in the opposite direction through the same angle. In this latter case, nothing in relation to the link-motion is disturbed, and the original diagram of ideal eccentrics (Fig. 39) will serve, the only difference being a change of the crank from OK to OK', and the latter line is the base line for the new diagram, as regards the angles of advance, while OK remains the centre line of the locus. This result is identical with that obtained before in Fig. 38, but by this way of reasoning we can easily ascertain through what angle the crank should be shifted in order to get the line $I'i^\circ$ at right angles with the new base line OK'. This angle is evidently $= I'i^\circ J'' = \beta$. (See Fig. 29.)

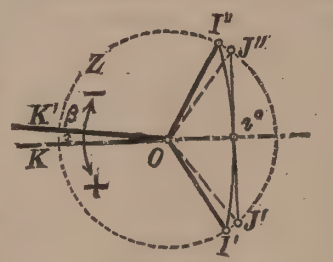


Fig. 39.

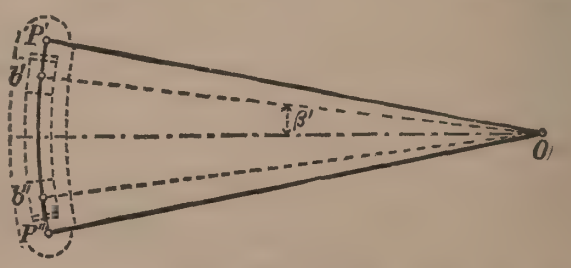


Fig. 40.

If the link is as shown in Fig. 40, the crank need only be shifted so that the points i' and i° (Fig. 33) are in a vertical line, and hence the angle β' (Fig. 40) should be used for the correction.

The corresponding valve diagram is shown in Fig. 41, where it will be seen that the lead remains nearly the same for the grades $Q'\,q'$ and q°, but it diminishes rapidly, as the link is raised farther and adjusted to the grades q'' and Q''. At the latter grade the lead may even become negative, in other words, the opening of the steam-port takes place after the crank passed its centre.

This method can evidently be applied with advantage only on engines which are principally used running forward, as is the case with marine engines and locomotives.

To be continued.

PROGRESS IN SCIENCE AND THE ARTS.

☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

The Plan that a Double Service of Pipes should be laid for urban supply, one for potable water, and the other for water to be employed in washing and for manufacturing purposes, gains some force from a recent rediscovery which seems to indicate that for the latter uses a mixture of organic impurity may sometimes be an advantage. An eminent French chemist, M. Gerardin, has, according to *Cotton*, published a a pamphlet in which he maintains that the causes which render water good or bad for manufacturing purposes have no relation to its purity, but that water largely impregnated with sewage matter is frequently possessed of important manufacturing qualities, while the pure water of artesian wells is much inferior in industrial value. He gives the following curious instances in point:—A person at St. Denis, who employs the muddy waters of the Groult, which marks 74 deg. of the hydrometre, for washing wool, failed completely when he tried to adopt the water of an artesian well, which was perfectly limpid, and marked only 44 deg. A manufacturer of gelatine at Paris, was stopped in his work one day, when the water company, which had formerly supplied him with Seine water, changed it, at his request, for the pure water of the Vaune, lately brought to the capital. Once the fact was ascertained, the Seine was supplied as formerly, and the manufacture proceeded as usual. M. Gerardin says that the industrial value of water depends greatly on the facility with which it deposits matters contained in suspension. Testing with milk of lime, the best water for manufacture is that in which the lime is deposited the most rapidly. The best manufacturing qualities are never found, he says, in water which gives much bubbles or foam. If water which is found suitable for manufacturing purposes be examined by means of a microscope, of at least 1000 diameters, it will be seen that the particles left in suspension are inert, or only affected by gravity, while water found unsuitable for industrial purposes seems animated by a gyratory influence which overcomes gravity, and keeps them in constant suspension. M. Gerardin gives this movement the title of "Brownian," after the English botanist, Robert Brown. This gyratory movement may be destroyed by the introduction of organic matter, &c., in the state of putrefaction, and then it becomes easy of decantation, and, in the industrial sense, good water. On the other hand, he has not found the means of giving the gyratory motion to any water which does not already possess it. The curious inference drawn from these facts is that sewage water, and the waste water of certain factories which are turned into rivers, while they corrupt the waters of such rivers as regards potability, endow them with important manufacturing qualities. Thus, the waters of the Seine above and in Paris, which are relatively valuable for manufacturing purposes, are still more so after the contents of the great sewage collector has been emptied into them; while, it may be observed, the ponderable matter becomes deposited within a very short distance.—*The Engineer*, xliv, 140.

Hardening and Toughening Copper.—With a view to communicate great hardness, toughness and homogeneity to copper and alloys of copper, so as to better fit them for certain industrial uses, Mr. W. E. Everitt, of Birmingham, takes oxide of manganese, preferably the native ore commonly known as black oxide of manganese, in a state of fine powder, and in the proportion of from one to six parts by weight of the said oxide of manganese to 100 parts by weight of the copper to be operated upon. He puts the copper and oxide of manganese together into the melting pot, or melting furnace, and when the copper is melted stirs the oxide of manganese well into it. As soon as the dross and scum have thoroughly separated from and arisen to the surface of the melted metal, the copper or alloy is ready to be poured into ingot or other moulds. In treating brass he proceeds as described with respect to copper, adding the required percentage of zinc to the melted copper. The alloys of copper to which the invention is specially applicable are alloys of copper and zinc, but he does not limit himself thereto, as his invention is also applica- to other alloys, of which the essential metal is copper. Besides rendering copper and alloys of copper tougher, harder, and more homogeneous, the treatment described facilitates the rolling of alloys of copper at a red heat, and thereby effects an economy of time and labor in the rolling process. Copper and brass treated according to the invention are admirably fitted for the manufacture of steam boiler tubes, bearing shafts or axles, axle boxes, sheathing for ships, and bolts and nails for the same, as well as for sheet brass and brass wire. Although in practice he has found the native black oxide of manganese to answer well, yet he does not limit himself to the use of that particular compound of manganese as other oxides of that metal, or compounds which on being heated yield oxide of manganese, may be employed with like results.—*Iron Age.*

The Swedish Matches of Butz, in Augsburg, have been found by C. Reischauer to contain the following constitution:

Chlorate of potassa	59.3
Chromate of Barium	21.6
Sulphur	2 3
Mineral matter insoluble in Hcl	4
Cementing material	12.8
	100.

—*D. Ind. Ztg.*, 1877, 329.

Divisibility of Electric Light.—Considerable interest has been enlisted in the project of illuminating Paris by the electric light by means of the *Alliance* machines and Jablochkoff's candles. We intend to abstain from all appreciation of these trials, for it will not be an industrial progress, but rather a financial affair; since the invitations of M. M. Denayrouze and Jablochkoff contain an attack upon the Gramme machines and the electric regulators in present use.

The author asserts that the Siemens' machine of Berlin occupies less space, and costs less than the Gramme machine. This is altogether untrue, in proof whereof the Prussian Government has ordered eight Gramme machines to light one of the State foundries, which would certainly not be the case if the domestic machines were better than the foreign.

The same author condemns all regulators, and asserts that they are applicable only when the electric light is intended for a central illumination, and where it is not necessary to distribute it. Would he assert that the beautitul stores of Bourges, the factories of Menier, the spinneries of Daours and Epinal, the lace works of Roubaix, and all the other large establishments which employ the Gramme machines and regulators, are satisfied with a central illumination?

It is useless to speak of the calculations which terminate the pamphlet. The estimates are not based upon a single serious fact.

We do not wish to depreciate the merits of the young Russian officer's invention; we have always thought, on the contrary, that it would some day render important service. What we are not willing to admit is what some people would assert, that the electric candles should altogether succeed gaslight.

We merely beg to remark that 303 Gramme machines are used, and with their regulators give most satisfactory results, and that 280 more are in process of construction, while there does not yet exist a single industrial application of Jablochkoff's candles.—*Revue Industrielle*, viii, 338.

Aniline Dyes.—There has been at various times much discussion on what may be termed the sanitary aspect of the aniline dyes. Although it may be at first difficult to see in what way the color of an article of costume can possibly affect health, yet the relation of the one to the other is not so remote as might be anticipated. Socks, stockings, and gloves are worn next the skin, and poisonous matters may thus be brought into the system; even the very wear and tear of ordinary articles of costume, in the event of the color not being of a very firmly adherent nature, results in a portion of coloring matter being liberated in the form of a fine dust, and thus inhaled by the lungs. In France stringent measures have had to be adopted to prevent the artificial coloration of cheap wines with "fuchsine." Recent experiments have now beyond doubt established that aniline dyes, at least the reds and blues, are in their pure condition comparatively inert, and that the ill effects which have been sometimes attributed to the use of these dyes are traceable, not to the pure coloring matters themselves, but to traces of arsenic which they contained, and which arose from inefficient purification subsequent to manufacture. Enterprising scientists may always be found who are willing to become martyrs, for science or for notoriety, and the present inquiry has had its self-sacrificing hero in the form of Herr Seidler, of Riga, who administered to himself three-quarters of a grain of aniline red every morning, for a period of five weeks, without any ill effects. When it is pointed out that a single grain of aniline red is said to be sufficient to impart a good pink color to fifteen gallons of alcohol, it would be necessary to drink an enormous quantity of artificially-colored wine in order to equal a single morning performance of Herr Seidler. So far the question is practically settled, the only remaining difficulty being our inability to ascertainwhether pure or impure coloring material has been used in any purchased article; and it will therefore be better,as a simple matter of precaution, to be on our guard against the indiscriminate use of aniline dyes for coloring purposes.—*Medical Examiner.*

Vulcanizing Wood.—A New York firm claims to have discovered a process for vulcanizing wood, requiring when the wood is green from the mill or tree, only from four to six hours in the preparation. By this process it is said that all kinds of wood and lumber are made hard. The fir, the cotton wood, the spruce, and cedar even, when treated by it, are rendered hard enough to be used as ties, and as such will last for an indefinite time, without being worn by the rail, or spike, or destroyed by decay.

But the effect of the treatment upon the southern yellow or pitch pine is really marvellous. The pitch is converted into oil, which is diffused through, and becomes homogeneous with, the fibre; it is then solidified and converted into resin. This imperishable substance fills all the pores, and so cements the fibres of the wood as to make it harder and stronger than oak, while it prevents it from absorbing air or moisture, from shrinking, cracking, warping or expanding.

But there are many other uses for which wood and lumber preserved by this process will prove invaluable. The railroads are maintaining 125,000 miles of fencing, the annual expense of repairing which is $10,000,000. This is another very large item which might be saved to the stockholders. Bridges can be made of wood treated by this process, which will be as strong,as safe and lasting as those of iron,and at a much smaller cost. The annual expense for repairing the woodwork of railroad cars is very great, especially freight cars,which are always exposed to the weather, and are constantly rotting. The lumber prepared by this process has the appearance of the precious woods, when manufactured and used for mechanical purposes. The vulcanizing develops in it, and throughout every portion of it, a susceptibility of the highest polish, more beautiful and more lasting than the most expensive varnish. A polish, which is not tarnished by any exposure to the weather, nor affected even by the strongest acids. The construction of cars of lumber so inexpensive, which will not rot, which will not swell, nor shrink, which requires no oil, paint or varnish, must result in another great saving to the railway companies.—*National Car Builder*, viii, 133.

Application of Brass to the Arts.—Brass is extensively used in a variety of manufactures. The locksmith constructs many of his locks wholly of brass, and many more partially of that alloy; as, for example, in padlocks, locks for cupboards, tills, desks, boxes, etc. He also employs brass in his players, follows, face-plates, striking-plates, handles, roses, and key-shields.

The engineer makes use of brass for every journal, for bearings, for plungers, propellers, and general fittings. The plumber employs it for pumps, bath fittings, plugs, cranks, etc.

The optician, electrician, and mathematical instrument maker, for nearly every article which he manufactures. Telescopes, microscopes with their stands, camera lenses and fittings,galvanic batteries,and electric machines, ships' compasses, and binnacles, may be named as indicating the demand for brass.

The stove and fender makes employs brass to relieve and give effect to his polished work; while the musical instrument maker beats it into trumpets and sounding appliances.

The makers of buttons and pins consume no small quantity for their wares.

The maker of gold-leaf beats brass into leaf, known as Dutch leaf, which is employed as a substitute for gold in the process of gilding.

The glass-blower employs it in a calcined state to impart color to his glass. Blue and green colors are produced from unmixed calcined brass; while a red-yellow or chalcedony is obtained when the brass is calcined with sulphur.

The color-maker adds pulverized brass to several of his compositions, and the ship-builder employs it largely for bolts, screws, and sheathing purposes.

The cabinet-maker adds great quantities of brass manufactures to his work, which includes in his every-day routine curtain poles, bands and hooks, picture rods, brass locks, hinges, buttons, rings, handles, roller fittings, sash fasteners and lifters, castors, rollers, hat pins and nails

The bell-hanger has nearly all his cranks and pulls made of brass. The gas-fitter employs it for his gas lustres, brackets, sunlights, and general fittings and connections. The wire-worker is an important consumer of brass wire for making wire cloth (used by paper makers,) as well as for the fire-guards, cages, etc.

The card-maker is also a considerable employer of brass wire for the woolen manufacturers' cards, and the book-binder for clasps and corners of his bindings. The traveler's bag-maker, bootmaker, and many other manufacturers in the ramifications of industry employ it in their every day vocations, and each year adds new applications to this, the most important alloy in the world.—*Crockery and Glass Journal*, vi, 17.

The Power of the Telephone has been tested by cutting the wire and completing the circuit by a man holding the detached ends, messages being transmitted both ways with the usual distinctness. Two, three and five men were introduced in the circuit, and every word was as distinctly heard as before any resistance was introduced. The electrical resistance was estimated from 40,000 to 200,000 ohms. In the telephones used, a soft iron disk is placed about a thirty-second of an inch from a permanent magnet, inserted in a wooden handle somewhat resembling a dice-box. Around the permanent magnet is a coil of insulated wire, to collect the electricity generated by the proximity of soft iron to the permanent magnet. The fine wire, after the induction of electricity, transmits the current along the line. At the other end, the current causes the metal disk there to vibrate in unison with the disk of the telephone at the transmitting end.

Leather Cloth.—Our contemporary, *D. Ind. Ztg.*, 1877, 338, reports that the National Sanitary Bureau has called attention to the fact that the so-called leather cloth imported from America, and used for the lining of baby coaches, contains a large quantity of lead. One sample analyzed gave 42.7 per cent. This lead is contained in the paint with which the cloth is coated, and which cracks and peels off when much exposed to the sunlight. A second sample examined in Magdeburg contained 31.6 per cent. of lead.

Recipe for Mixing and Applying Vermilion.—*The Hub* gives the following recipe for mixing and applying vermilion: For carriage parts or panels, prepare the work by coating with pure white lead, sufficient to form an even and clean surface. Mix the vermilion in an earthen vessel, using a stick or wooden pallette-knife to stir it with equal parts of Japan gold size and hard-drying body varnish. Mix to a stiff paste, and add sufficient turpentine to thin it for spreading evenly with a camel's hair blender. The vessel should then be set away in a clean place, to allow the mixture to assimilate, for vermilion, owing to its sensitiveness, should never be ground in the mill or come in contact with metal surfaces. When it has set a few hours, it should be stirred well, and its application may then be begun. It must be laid on evenly and rubbed no more than necessary. Frequent stirring is necessary, that the heavy globules of color may not fall to the bottom, leaving near the surface those which are lighter and which have an orange tint. Two thin coats are generally necessary, but the surface should not be rubbed, not even with the dusting brush. When the second coat is dry, put a little of the color into a cup of hard drying-varnish, to form color and varnish, which should be applied with a fitch hair varnish brush. This process produces a pure vermilion job. If it is to be glazed with carmine, it is best to add a little carmine color to the second coat of vermilion, and to the color and varnish, to make a purer carmine-glazing. Carmine tends to prevent the darkening of the vermilion by partially excluding sunlight, but of course the painter does not always desire to use carmine with it. The brilliancy of vermilion is heightened and rendered more permanent by an association with other colors. Red has its complementary in a mixture of the two other primaries, blue and yellow, which form *green*. A neutral color, white or black, harmonizes with it, but the color is not so itensified as it is by green. A stripe of green over red will not only attract the eye, but will make the latter less likely to look faded or dark, because its complementary color being present and intensifying it, the eye would not so quickly discern any change that might take place.—*Western Manufacturer, iv*, 518.

Parisian Copying-Ink—How to Make It.—The best kinds of copying inks are, as is well known, prepared by adding a percentage of alum, sugar and glycerine or salt to the extract of logwood. Such inks have a violet tint, and gradually become blacker on paper. The copy is, however, very pale at first, and is often indistinct. The Parisian copying ink is distinguished from the common kinds by its appearance more or less yellow in a liquid state and by producing a distinct bluish black on paper. It has the additional advantage of preserving its fluidity, while the common kinds soon thicken. Professor Gintl recommends the following method of preparing an ink which has all the advantages of the Parisian: A strong solution of logwood extract is treated with one per cent. of alum, and then with as much lime water, so that a permanent precipitate is formed. Some drops of weak chloride of lime is then added so that a perceptible bluish black color is attained and hydrochloric acid is added by drops till a red solution is obtained. A little gum is then added with 0.5 per cent. of glycerine.—*Paper Trade Journal, vi*, 269.

New Anti-Corrosive for Boilers.—Bohig, of Eisenach, prepares magnesia for the purpose of combining with the mineral salts usually found in the feed-water of boilers, and precipitating them without doing hurt to the boiler-plate. The preparation is said to separate the bicarbonates of calcium magnesium and iron, precipitating at the ordinary temperatures, aluminates, silicates and similar bodies present in water. The water is mixed with the preparation before feeding, and fed direct into the boiler.

—Various correctives have been used, for lead poisoning to which workmen employed in the manufacture of white lead are always liable, both by inhaling the dust and in touching the lead with the hands. Among these the latest and most simple is a careful washing of the hands in petroleum. Three washings a day are reported to be sufficient to prevent all serious danger of poisoning. The benzole in the petroleum is said to scour the skin and remove the dust of lead, and the fatty substance in the oil prevents the absorption of the lead salts. The experiments made in petroleum used in this manner give such good results that it is proposed to use the same material as a guard against poisoning in other industries where salts of copper or mercury are used.—*Western Manufacturer, iv*, 518.

ENGINEERING—CIVIL AND MECHANICAL, &c.

How the Secret of Making Cast Steel was Stolen.—Philanthropy was never abused so shamefully, as in the robbery of Huntsman, of his secret of manufacturing cast steel. The main distinction between iron and steel, as everybody knows, is that the latter contains carbon. The one is converted into the other by being heated for a considerable time in contact with powdered charcoal in an iron box. Now, steel thus made is unequal. The middle of a bar is more carbonized than the ends, and the surface more than the centre. It is, therefore, unreliable. Uniform work cannot be made out of it. For many purposes it will answer, but where accuracy is required it fails. Nevertheless, before the invention of cast steel there was nothing better.

In 1760 there lived at Attercliffe, near Sheffield, a watchmaker named Huntsman. He became dissatisfied with the watch springs in use, and set himself to the task of making them homogeneous.

"If," thought he, "I can melt a piece of steel and cast it into an ingot, its composition should be the same throughout."

He succeeded. His steel became famous. Huntsman's ingots for fine work were in universal demand. He did not call them cast steel. That was his secret. About 1770 a large manufactory of this peculiar steel was established at Attercliffe.

The process was wrapped in secrecy by every means within reach—true and faithful men hired, the work divided and subdivided, large wages paid and stringent oaths administered. It did not answer. One midwinter night, as the tall chimneys of the Attercliffe steel works belched forth their smoke, a traveler stopped at the gate. It was bitterly cold; the snow fell fast and the wind howled across the moor. The stranger, apparently a plowman or agricultural laborer seeking shelter from the storm, awakened no suspicion. Scanning the wayfarer closely, and moved by motives of humanity, the foreman granted his request and let him in.

Feigning to be worn out with cold and fatigue, the poor fellow sank upon the floor, and soon appeared to be asleep. That, however, was far from his intention. He saw workmen cut bars of steel into bits, place them in crucibles, and thrust them into a furnace. The fire was urged to its extreme power, until the steel was melted. Clothed in wet rags, to protect themselves from the heat, the workmen drew out the glowing crucibles, and poured their contents into a mould. Mr. Huntsman's factory had nothing more to disclose. The secret of making cast steel had been found.—*Railroad Journal, iv*, 157.

Iron in the Construction of the Piano-forte.—The first intention of the application of iron—of the harp-shaped metallic ring—was not to enable the instrument to endure the constant strain of the strings. It was supposed that the metal would expand and contract uniformly with them, in the severe changes of this climate, and that in this manner the instrument would remain longer in tune, although the actual pitch might vary.

In 1837 the highly-skillful American maker, Mr. Jonas Chickering, conceived the bold idea of constructing a frame entirely of iron, and in the same year made his first square piano-forte in this way. In 1840 he produced the first grand piano-forte with an entire iron frame all in one casting. By this remarkable invention the piano-forte gained in truth an "iron constitution," competent to bear the atmospheric changes of this climate, and to it all subsequent successes are referred.

It was a great achievement to obtain a frame capable of resisting the enormous strain of the strings, but this advance imperatively led to innumerable variations being made in various details, for the attainment of an equilibrium, without which the promised gain could not have been fully realized. The softer tissues still remained of wood of various kinds, and other such essential materials. With the acquisition of an iron frame or vertebra equal to the tensile strain of thirty tons without danger of fractures, came the temptation to employ strings of greater thickness, with a tension of from eleven to sixteen tons. These strings, stretched as near as possible to the limit of elasticity, that they might give forth the most vigorous vibrations, required to be set in motion by blows from hammers specially adapted for the purpose. (Voices similarly strained on the highest notes within their compass also have the most brilliant quality, as for instance the "G" of Mr. Santley and the chest "C" of Tamberlik.) Then, again, the increased powers of the instrument made greater demands on the sound-board.—*Dr. S. A. Pearce, in the Popular Science Monthly for October.*

Torpedoes are beginning to lose their prestige, and already it is said that a mechanic employed in Chatham Dockyard has invented a screen or shield for protecting the whole bottom of a ship. The shield is of sufficient substance to resist any torpedo, can be raised or lowered in five minutes, and stows away snugly on the topsides of an ironclad.—*Eng. Mechanic* xxv, 584.

Sliding of Wheels.—An engineer, whose name does not at this moment recur to us, sends us a note of great interest on the sliding of locomotive wheels. He states that there is sliding when the velocity of rotation of the wheels is greater than their velocity of translation. This, according to the author of the note, is always produced during the descent of the train, and is always proportionate in intensity to the velocity. The suppression of this phenonenon would result in an economy of fuel. The note leaves undecided the cause of the occurrence, which, according to the remarks of M. Bertrand, is caused by the resistance of the air.—*La Nature*, v, 191.

An Unsinkable Ship.—Mr. Pollexfen, the engineer-in-chief of the Sligo Harbor improvements, has supplemented his pamphlet, "The Unsinkable Vessel of War," with two letters which practically and briefly explain the principle upon which he proposes to construct a vessel of war which shall be at the same time unsinkable and impregnable. The plan proposed, which is one well worthy of a trial, is simply and clearly shown by Mr. Pollexfen's illustration of a wooden ship laden with a cargo of timber, and then unloaded so as to form a rectangular space, having on each side a solid body of timber, and at her bottom a third of her depth of the same material. In this space is to be placed an armored compartment fitted in all points precisely as our ironclads. "If," sayes Mr. Pollexfen, "the iron armor compartment does not exceed in weight the timber cargo taken out of the space, it follows to demonstration that the vessel will float in sea-worthy trim, and, in fact, just as though the cargo had not been removed."

A New Safety Ladder has been invented to aid in the escape from a fired building. It is flexible, so that it may be kept rolled near a window, ready to unroll for use by fastening it to the window inside; the rounds are supplied with studs, which will keep it from the building so as not to interfere with the passage down.

The Compression of Cotton has been improved by Burr, who increases the capacity of the compress, allowing the use of any fastening in use. In transportation, a car will carry one-half more than was carried ten years ago.

MINING, METALLURGY AND MINERALOGY.

New Puddling-Furnace.—The new Puddling-Furnace recently devised by Bouniord, in England, operates in theory, like the Bessemer, by burning out the carbon from the molten metal by means of a blast of air inserted into the bottom of the furnace. In the Bouniord furnace the blast-tube is prolonged as a spiral-shaped "worm" into the mass of molten metal, and by being rotated by means of gearing, actuated by means of a proper motor, sets the mass in agitation. The furnace, like the Bessemer, is emptied by being tilted.—*Maschinen-Constructeur*, x, 319.

Cotterite.—Professor, Harkness, at the late meeting of the Mineralogical Society, exhibited a specimen of quartz found at Rock Forrest, Mallow. The peculiarity of the specimen was the beautiful lustre on the pyramidal planes—a pearly lustre and not vitrite. It was probably some peculiar condition of siderite. The specimen was found on the top of a carboniferous limestone quarry, beneath a layer of red clay, strongly impregnated with iron. The deposit on being analysed was found to contain much iron. As Professor Harkness obtained the specimen indirectly through Miss Cotter, he proposed to call it Cotterite.

Duporthite.—At the same meeting Mr. J. H. Collins read "Note on Duporthite, a new Asbestiform Mineral." This mineral occurs in fibrous masses, occupying fissures or shrunken cracks in the serpentine of Duporth, near St. Austell. The thickest veins were not more than 1½ inch. The fibres are placed transversely across the vein, making, generally, an angle with the walls of 70°. The mineral is greenish to brownish grey, has a silky lustre, a hardness of about 2, and a specific gravity of about 2·78. Thin fibres are flexible, like asbestos. Heated in a matrix the mineral gives off a little water, and becomes lighter colored; in forceps thin fibres fuse to dark glass in the hottest part of the flame. The spectroscope shows the sodium and calcium lines distinctly, but no trace of potash or lithium. The following is the analysis:—Silica, 49·21; alumina, 27·26; protoxide of iron, 6.20; magnesia, 11·14; lime, ·39; soda, ·34; water, 3·90; water hygeo, ·68-99·27. About half the water was given off more readily than the other half. He should regard the more obstinate portion of the water as basic. As he could not find any mineral whose composition at all approached it he proposed to call it Duporthite, from the locality, Duporth, in which he discovered it.—*Iron*, x, 266.

Mercury in Japan.—According to Mr. Plunket, cinnabar occurs in two localities in Japan, but neither of these deposits is now worked. One mine in the northern part of Nippon is said to be very promising, but its present proprietors are not inclined to expend money for its development. The other mine is near Ainoura, on the peninsula of Hirado, in Matsura Kori of Nagasaki ken. Mr. Gower, who formerly superintended the working of this deposit, reports it to be valuable. The mine was opened under his direction some years ago, and a retort furnace was erected for the distillation of the metal from the ore. The furnace was worked successfully, and mercury was produced in some quantity. During the absence of Mr. Gower, however, the workmen by careless firing, melted the iron retorts, and, discouraged by this accident, the owners decided to abandon the undertaking. The cinnabar occurs here as a local impregnation in sandstones of the coal-measures, and filling small seams and fissures in the rock.—*Iron*, x, 263.

MISCELLANEOUS.

Stellar Theology.—An English clergyman points out that the leading stars in the constellation Orion form a figure closely resembling the letter *aleph*, the first of the Hebrew alphabet. He also makes out the Greek *omega* in the same asterism, and sees in these facts, or fancies, important theological suggestions. But we will let him speak for himself: "If the assumption of the odds being so great against arbitrary arrangements by natural law (not the law of a Being) be admitted, is it at all unreasonable to infer that the Almighty Creator has intentionally arranged the stars in this and other forms, as the seven stars in the Plough or Charles' Wain in the Ursa Major, the sickle in Leo, the cross in Cygnus, and others, so as to render it impossible for any unprejudiced thinking and reasoning person to doubt the existence of a creator; but further, that they are not only signs for that purpose, but that this one, Orion, is the particular sign of the Deity, and containing the indication of the nature of that Deity, Alpha and Omega, the first and the last, or the Eternal, and also the three stars in the belt, and the three stars below the belt indicating the Trinity of persons? This may seem fanciful, but the string of coincidences is very remarkable." We trust that this sort of thing is not going to spread; if it does, somebody will soon be objecting to the study of astronomy in the public schools on the ground that it has "sectarian" tendencies. If the Trinity is found in Orion's belt, the whole Thirty-nine Articles can doubtless be discovered by diligent search among the constellations. Who will be the first to get out an edition of the "Westminster Catechism" illustrated by star maps?—*Boston Journal of Chemistry*, xii, 33.

The International Exhibition at Paris in 1878.—Our contemporary, *Revue Industrielle*, issue of August 22d, contains the official decree of the Superior Council relative to the nomination of a jury of awards for the Exposition of 1878. It appears that the sum of 1,500,000 fr. has been allowed for awards, which sum is to be distributed and properly awarded by a jury of 650 members, 350 foreigners and 300 Frenchmen. The foreign members to be selected from the various nations in proportion to the surface occupied by each one, and the number and importance of their exhibit. There is likewise to be a supplementary jury, consisting of 325 members, 175 foreigners and 150 Frenchmen, selected in the same manner and subject to the same conditions as the titulary jury. The foreign jurors are selected by their respective governments; while those of France are nominated by decree, on the proposal of the Superior Commission. All the nominations are to be made by January 1st, 1878.

The Superior Commission is to assign the jurors to the respective classes. The international jury is to complete its work between June 1st and September 1st, inclusive. All concerning groups 7, 8 and 9 during the entire exhibition, are subject to special regulations comprised under the heading—Elementary Products of Agriculture and Horticulture.

The distribution of awards is fixed upon the 10th day of September, 1878. The awards at the disposition of the jury for works of art are as follows:

17 medals of honor for objects of art of French origin.
32 medals of the first class.
44 " " second class.
48 " " third "

The exhibitors that have accepted the position of members on the art jury are excluded from all competition, as are likewise all other exhibitors that are members of juries awarding in their class. The awards at the disposition of the International jury, for the collective or individual exhibition of agricultural and industrial products, are

100 grand prizes and exceptional allocations in silver.
1000 medals of gold.
4000 " silver.
8000 " bronze.
8000 honorable mentions.

All the medals are of the same die, the difference being only in the metal composing them. The rules and regulations which govern the actions of each jury are similar to those which governed those of our exhibition in 1876, and are not of sufficient interest to be enumerated.

The University of Tuebingen will celebrate this year its four hundreth anniversary. It was founded by Count Eberhard im Bart, best known through Uhland's poems. Uhland, who was a native of Tuebingen, also occupied a chair at the University. The University of Upsal will also shortly celebrate its four hundredth anniversary.

Commercial and Industrial Museum in Paris.—It is intended to establish in Paris a Commercial and Industrial Museum, where the raw materials of the entire world shall be exhibited, and a description of the different processes to which they are subjected, given to the public. All the products are to be methodically classified, so that each person, be he savant, merchant, manufacturer or consumer, can easily find whatever he desires. The place of production, of fabrication, sale, purchase, or consumption are to be clearly indicated on placards. The Museum is to contain a special library and a hall in which lectures upon commercial and industrial subjects are to be periodically delivered. The idea originates with the Society of Commercial Geography in Paris.—*Moniteur Ind. Belge*, iv, 371.

While the Phylloxera is Ravaging the Vineyards and the Colorado beetle threatening the potato fields of France, yet another plague is reported to have appeared in the Pyrenean districts. This time it is the groves and woods of chestnut trees which are menaced. According to the *Courrier de Bayonne*, a large number of these trees in the canton of Espelette and elsewhere have been attacked by small black insects, having shining bodies, with six legs and small wings, but apparently incapable of flying. These insects, it seems, eat their way in beneath the bark of the trees at the level of the ground, and then work round the tree between the bark and the hard wood, up to a height of some ten feet. The conducting vessels of the sap being thus destroyed the trees soon dry up and wither. The insects are generally followed by a species of worm, which ascends even higher than the former eating channels not only beneath the bark, but even into the hard wood of the tree. The losses already occasioned by these two scourges are stated by the *Courrier* to be very great. Entire plantations have been destroyed, the oldest and strongest trees being attacked as well as the young and tender.

Banishing Garden Pirates Wholesale.—Mr. Thos. Elsley, of 32 Great Portland street, W., has brought out an ingenious instrument for cleansing trees from caterpillars, invented by a Frenchman, M. Damaniou, of Roziere, near Sainte Foy-la-Grande, and which, after a careful trial by the engineer in-chief in charge of the public thoroughfares in the Department of the Seine, has been adopted by the French Minister of Public Works. The instrument consists of a brass tube about 4ft. long and 1in. in diameter, inclosing another of the same length, which is worked by telescopic action. To one end of this an india-rubber tube of equal length, with a mouthpiece, is affixed; and at the opposite end is a small brass receptacle for oil, with a fine spray nozzle. Petroleum, being the most deadly liquid known for the destruction of caterpillars, is preferred to all other oils for use in this instrument, through which it is blown in the form of a dense fine spray on the nests of the insects, causing immediate destruction to them without injuring the trees.—*Eng. Mechanic*, xxv., 579.

The Destruction of Two Spans of the Union Pacific Railway Bridge between Omaha and Council Bluffs, during a storm in the early morning of last Saturday, is one of the strangest occurrences on record. It is variously ascribed to lightning, and a cyclone and water spout. It is probable that the latter two combined did the work. Arrangements were at once perfected for transferring all the traffic which usually crosses the bridge, at other points, so that but little delay and expense therefrom will result. A Howe truss with temporary trestle will be completed across the chasm within fifteen or twenty days, and traffic can then be resumed as usual while permanent spans are being prepared. The American Bridge Co. has the matter in charge.—*Chicago R. Rev.*, xv, 65.

—The San Juan extension of the Denver and Rio Grande narrow-gauge road has been completed to Garland Station, 27 miles from La Veta. The remarkable enterprise displayed in pushing forward this extension, which attains an elevation of 9,339 feet above sea level—the highest point yet reached by a locomotive on the North American continent—is only equaled by the quietness with which it has been done, so far as the outside world is concerned. The San Juan mining region is one of the ultimate destinations of the road, to which it will doubtless be pushed forward with the same vigor that has hitherto characterized its management. The natural scenery along the line is exceedingly picturesque and beautiful, and will constitute a great attraction for pleasure-seeking adventurers and tourists.—*National Car Builder.*

—An English paper says the British Patent Office Museum has purchased, at a cost of £28 15s., the Rev. Patrick's Bell's Reaping Machine. It appears this machine was never patented, but that it has been purchased as an important link in the history of invention as applied to reaping machines,

Record of New Railroad Construction.—The last number of the *Railroad Gazette* has information of the laying of track on new railroads as follows:

Jamesville & Washington.—Extended south 15 miles to Washington, N. C.

Spartanburg & Asheville.—Extended from South Pacolet River, S. C., northwest to Tryon Mountain, 8 miles.

East & West Texas.—Extended 15 miles to a point 35 miles east by north from Houston, Tex. It is of 3 ft. gauge.

Wheeling & Lake Erie.—Extended from Milan, O., north to Huron, 7½ miles. Track also laid from New London, O., north 1 mile, being 8½ miles in all. It is of 3 ft. gauge.

Utah Western.—Extended from Lake Point, Utah, south to Tooele, 11 miles. It is of 3 ft. gauge.

Northern Pacific.—Track on the *Puyallup Branch* is laid from Tacoma, Wash. Ter., eastward 12 miles

This makes a total of 69½ miles of new railroad, making 1,013 miles completed in the United States in 1877, against 1,253 miles reported for the corresponding period in 1876, 614 in 1875. 962 in 1874, 2,252 in 1873, and 3,962 in 1872.

Narrow-gauge Railroad to Saratoga.—Some wealthy gentlemen of this vicinity and New York, says the Troy *Times*, are considering the practicability of constructing a narrow-gauge railroad between Albany and Troy and Saratoga Springs. Estimates of the cost and of the probable receipts of such a line are now being made, and if it be determined that the road will pay expenses, it will be constructed. The route will be over the shortest practicable line, running direct from Mechanicville to Saratoga, and thence possibly to Saratoga lake. We should not be surprised to see the road built at an early date.—*Railway World, iii*, 878.

The American Piano-forte.—The piano-forte appears in four principal forms: as grand, square, upright, and curved, the latter being a newly designed model, by Mr. J. W. Otto, of St. Louis, Missouri. The American grand piano-forte is, however, the greatest triumph of inventive genius and skill, aided by modern physical science; and this fact being acknowledged in all parts of the civilized world, foreign trade has been introduced to such an extent as to make the industry one of the largest in the United States. All the makers here daily strive for pre-eminence, and endeavor to surpass one another in the superior excellences of the smallest details, if not in the novelty and value, of their own respective inventions. No pains or expense are spared to obtain improvements, in the hope that these may, at least, lead to subsequent discoveries in the many untrodden paths of acoustical science. In this respect they resemble the old violin-makers of Italy, who also took a pardonable pride in their productions, which are the result of similar prolonged strivings.—*Dr. S. A. Pearce, in Popular Science Monthly for October.*

Pool's Arbor, or Mandrel.—Messrs. A. A. Pool & Co., Newark, N. J., are at present manufacturing an article in the shape of a Hardened Steel Arbor, or Mandrel. The advantages of a hardened arbor over a soft one are apparent. This arbor is hardened to a depth of about one-sixteenth of an inch, leaving the interior soft and tough, with no liability of breakage. The greatest care is taken to make them perfectly true, and they are ground on stationary centres to accomplish this end. They are made in regular sizes, varying in diameter from one-quarter of an inch to two inches, and all intermediate sizes, the regular lengths varying from three-and-a-half to fifteen-and-a-quarter inches.

Another New Machine.—Charles Kellogg, of North Amherst, has invented a machine for fastening buttons on to cards, a process heretofore done by hand with a needle and thread, a day's work being about 40 gross for a smart workman. The machine is calculated to fasten one gross per minute on cards containing two dozen each, or 60 gross per hour. It is about two feet long and 15 inches wide and as many high, and fastens the buttons to cards with fine wire. Four buttons are fastened or wired at a time, the card moves along and four more are wired, and so on until the required number is on the card, when another card is pushed is pushed along from the top of a pile of two hundred or more on the machine. One girl can attend to each machine.—*Boston Commercial Bulletin.*

—The Brooks Locomotive Works, Dunkirk, New York, have a contract with the Covington, Columbus and Black Hills Railroad Company for one 42-inch gauge passenger engine, and a contract with the Erie Railway Company for five consolidation engines.

—New car wheel works are being erected at Detroit, near the works of the Detroit Bridge and Iron Company. The works are of substantial character and are neatly completed.

—The Schenectady Locomotive Works are building five locomotives for the Chicago, Milwaukee and St. Paul Railway Company.

—The Massillon Iron Bridge Company of Massillon, has contracted for putting up a new iron bridge of sixty-three feet span at Bozrahville, Conn., and also one of fifty feet span at Lebanon.

CORRECTION.—In our issue of Sept. 8th, the description of a Shuttle Driving Mechanism for Sewing Machines, it was stated that the device was manufactured by J. M. Perdue & Co. We are informed that this is not correct, and that the firm named sell the right to manufacture.

—Pigeons are proposed for communication between light-houses and lightships and the shore to carry intelligence of danger and disaster. They are employed in the English herring fisheries along the coast of Scotland for the same purpose.

—The pottery furnaces at East Liverpool, Ohio, use natural gas for fuel, houses are lighted and warmed with it, and cooking is done with it at the cost of $1.50 a month. Wells are sunk, and the gas comes up with great pressure, which is collected in a gasometer and distributed in the ordinary way.

—It is noted as an evidence of reviving business that the manufacturing establishments of Providence, R. I., found it necessary to employ 3,000 additional hands week before last.

—S. W. Beatty & Co., of Saco, Me., recently shipped to the Eagle and Phoenix Manufacturing Company, Columbus, Ga., a lot of leather belting that took the middle or best part of 721 ox hides for its manufacture. This is said to be the largest shipment of leather belting ever made from New England.

—The vegetable ivory, of which a wide variety of toys, small articles of use or ornament, etc., are made, is the hardened albumen of the seeds of a certain species of palm indigenous to Central America. A few years since this material was worth but $20 per ton, but it now readily brings $80 at the ship's side. The vegetable ivory palm has a short, stumpy stalk, and produces its flowers and nuts in a spathe or valvular envelope quite near to the ground.

—A Platteville, Wis., mining company have taken out 70,000 lbs. of lead ore this summer, and have 50,000 lbs. or more in sight, and the indications are that the largest part of the lode has not yet been reached.

—The Temple of Diana, at Ephesus, was 425 feet long and 200 feet broad, with 127 columns 60 feet high. It required 220 years to build it. We have plenty of contractors at the present day who would take the job and give a bond to compete the temple in five years.

Rapid Transit and Refrigerating Cars and ships have distributed fresh fruits and meats in the foreign market, and greatly extended the home market.....A skimmer and fork have been so combined that the instrument may be used for both; and so that the two parts slide upon each as may be desired.....An electrical apparatus has been invented which will indicate an overstrain or weakness in a bridge, or roof, or other structure.....The electric light is becoming useful to the Russian Government for military purposes. They have been experimenting with the object of increasing the distance to which the light produced by electricity may be thrown. Objects have been made visible at the distance of upwards of 3,000 yards.—*Sci. American*.....Prof. Langley, in the *Am. Journal of Science and Arts*, suggests two courses to eliminate the personal equation.....A record kept by a railroad line showed that there were over 3,000 hot journal boxes in one month. *The Railroad Gazette* calls attention to the necessity of remedying this matter.....Prof. Henry's portion of the report of the Smithsonian Institute for 1876 has been printed. .....An observer has been testing the rapidity with which water may be absorbed by plants. A withered raspberry branch became erected in ten minutes. The water was taken up as rapidly as by a lump of sugar.....A volume of logarithms, prepared by Mr. Nemours, containing tables for all numbers up to 434,000,000,000, is being published by the Royal Academy of Belgium.....The dispute continues about lime-juice being necessary to sledge parties. Captains Markham and McClintock differ as to its good effect in keeping men from the scurvy.....A steam digger has been constructed to dig ground for hops, sugar plantations or other agricultural work. .....The steam road-rollers of Aveling & Porter are being used by the Blake Crusher Co. in connection with their crusher from quarry to quarry.....Neafie & Levy will launch a wooden tug boat next week for New Orleans parties and to tow on the Mississippi river. She is 108 feet long, 12 feet beam, and 9 feet hold. The engines are of the condensing pattern, 36 by 32. At this establishment a pair of boilers are being built for the steamer Alacanti, owned in Cuba, and a large marine boiler is also in course of construction for New Orleans.....At Cramps shipyard the Clyde steamer Equator is undergoing extensive repairs to her hull, and the boilers are being tinkered. The steamer Fanita, of the same company, is also receiving thorough repairs, while those to the steamer John W. Everman are being finished. The Steamer Santiago de Cuba is also at Cramps'. The firm are making six boilers, 11 by 12, for the United States monitor Terror.....I. P. Morris & Co. have just turned out the largest band-wheel ever manufactured sn the United States. It is 20 feet diameter and 26 inches face, and intended for the Calumet and Hecla Copper Mining Company of Michigan.....At this time a heavy volume of freight is going Southward, by both rail and steamer, consisting in the main of stoves, provisions and dry goods. The Clyde lines South are crowded with outgoing merchandise.

ANSWERS TO CORRESPONDENTS.

RAIN WATER. (B. W. P., Toledo.) This is not pure; it contains nitrates and nitrites, (especially during thunder-storms) salts of ammonia sulphuric acid (in cities) and organic matter.

CARBON BRONZE. (A. T., Allentown, Pa.) We do not know what it is made of, and have never used it or seen it used. It is used in Pittsburg to our knowledge. We cannot say anything one way or another about it.

VERY HARD BRONZE. (C P. R., Bethlehem.) Copper 2, tin 1, make a bronze very hard on steel tools. Pusey, Jones & Co., of Wilmington, Del., have a "calender-roll" metal which we would prefer to work on time rather than by the job.

WIRE-DRAWING IRON. (G. M. A., Nashville.) Wire-drawing improves the tensile strength of iron from 40 per cent. upwards; but it does not increase the density or gravity. On the contrary, iron wire has generally a *lower* specific gravity than the bar it was made from.

IRON FOR CASTINGS. (L. T. M., Niles, Mich.) If for machine-tool frames, &c., closeness of structure is desired; if for ornamental castings, fluidity chiefly; for beams, strength and rigidity. Steinway's piano-frame metal is the best iron we have seen, as regards tensile strength.

HORN WORKING. (A. P. S, Mobile.) There are two troubles—the laminated or fibrous nature of the material and the necessity of working it hot, all the way through. Two common combs are struck out of one plate, the teeth of one coming out from between those of the other.

ALLOWANCE FOR EXPANSION UNDER TENSION. (W. H. T., Rome, Ga.) There are a few cases where this element need be allowed for. Thus a ton weight on a wrought-iron bar an inch square will elongate it but $\frac{1}{10000}$ or one hundredth of one per cent. The range of length between summer and winter extremes is about $\frac{1}{2000}$, or one-twentieth of one per cent. with wrought iron.

PROPORTIONS OF PATTERNS AND CORED CASTINGS. (S. P., Boston.) Your rule for shrinkage is all right enough as far as the pattern goes; but the pipe sketched may be too thin on account of the expansion of the core. Cores expand, and hence require a trifling allowance on large ones.

CRANE-CHAINS BREAKING. (C. S. S., Binghampton.) You ought to re-anneal them once every few months. Most crane-chains break when a careless attendant checks a load suddenly when lowering it.

DOG-SKIN GLOVES. (S. R, Utica.) These are really not always dog-skin, but are made of Cape sheep-skin.

EDITORIAL CORRESPONDENCE.

PHILADELPHIA, Sept. 3d, 1877.

EDITORS POLYTECHNIC REVIEW:—

In my letter of August 21st, the letter n printed at the end of the simplified Lamé formula, should stand at the beginning of the next line. I would call the attention of your readers to this mistake, as it materially alters the meaning of my letter.

Thus the correct formula will be

$$\text{Thickness} = \textit{inner radius} \left(n + \frac{n^2}{2} \right)$$

the letter n representing the bursting pressure, divided by the cohesion of the material.

Very Respectfully, A. SCHLEICHER.

In lieu of the "Selected List of U. S. Patents," we give this week, from official sources, the

RULES OF PROCEEDINGS OF THE GERMAN PATENT OFFICE.

NOTICE.—Pursuant to section 20 of the Patent Law of the 25th of May of this year, we issue the following provisions concerning the notification of inventions:

SECTION 1. The application and every accompanying drawing or specification must be signed by the applicant or his attorney. Explanations of the subject of the invention may not be given in the application itself, but only in the documents annexed to it.

SEC. 2. Each annex to the application must be furnished with a consecutive number. Each annex is, as far as it does not deal with models or samples, to be handed in in a duplicate.

SEC. 3. The application must contain the statements as hereafter required, as far as possible, in the given order of succession:

a. A short but accurate specification of what forms the subject of the invention. From the specification there must distinctly appear the claim for a patent—*i. e.*, that which the applicant considers new and patentable.

b. The petition that a patent be granted for the subject of the invention so described. If only an additional patent is to be granted (section 7 of the Law of Patents), the applicant must expressly state this and the original patent, as also its number and the year when granted be stated. If the patent is only to take the place of an existing patent (section 42 of the Law of Patents), the applicant must likewise also expressly state this, and, at the same time, add thereto the documents about such patents in place of which the patent is to stand. The petition is in this case to be confined to a transformation from a territorial patent to one for the whole empire. If at the same time a patent is claimed for an improvement, a special petition must be made for the same.

c. The declaration that the governmental charges of twenty marks (section 20 of the Law of Patents), is already paid into the treasury of the Patent Office, so that it will be paid in along with the application.

d. The statement of name, rank, and residence of the applicant, as far as the application is effected by an attorney. The latter must hand in a power of attorney, signed by the applicant. If an attorney is appointed for an applicant living within this realm, and if the attorney is to be entered as such in the patent roll (section 19 of the statue), then it must be expressly stated in the power of attorney.

In appointing an attorney on the part of an applicant for a patent not residing in this realm, it is taken for granted that such agency extends to the rights and powers specified in section 12 of the statute.

e. The enumeration of the different annexes to the application, giving their number and contents.

SEC. 4. For all written documents of applications, paper of the size of thirty-three centimeters height by twenty-one centimeters must be used. For the writing, deep black ink (not sticky) must be used. Of each of the drawings there must be handed in duplicates. For the first and principal copy, white, stout, and smooth drawing-paper (so-called Bristol or carton paper) of the size of thirty-three centimeters height by twenty-centimeters breadth; or thirty-three centimeters height by forty-two centimeters breadth, or thirty-three centimeters height by sixty-three centimeters breadth must be used.

The drawing, as also all writing on the principal copy, must be done with China ink, in deep black lines—not be colored or tinged. The drawing must be enclosed by a plain marginal line, which is to be drawn two centimeters back from the edge of the paper. All writing must fall within the space enclosed by the marginal lines.

The signature of the applicant is to be affixed in the lower right-hand corner. On the upper side of the sheet a space within the border-line, of at least three centimeters height, must be left free for number, date, and a specification of patent.

As a second copy, a tracing of the first and principal copy on drawing-cloth is to be handed in. In this copy the use of mixed colors is permitted and desired. The drawings may not be folded or rolled. They must be packed so as to arrive at the Patent Office in a smooth condition.

SEC. 5. All weights and measures must be given according to the metrical system, statements of temperature according to Celsius, those of density as specific weights.

SEC. 6. The specifications must confine themselves to what is pertinent towards forming a judgment of the application for a patent. Explanations of a general character should be avoided. Moreover, the specifications must be so arranged as to adapt themselves for publication on granting of patent. In the summary in conclusion the claims for a patent should be specified more closely than done in the application.

SEC. 7. The subjoining of models and samples is desired so far as it may aid in giving a clear idea of the invention. It should be done when without this the judgment of the application for a patent cannot take place with any certainty.

COSTS AND CHARGES.

The costs and charges, which, according to the provisions of the Patent Law of 25th of May of this year must be paid into our Treasury, are, for the sake of convenience, not to be sent in with the applications, but, by post office order, addressed to the Treasury of the Imperial Patent office. The post-office order, must, however, if it is a case of a grant of a patent, show the name of the applicant, and the subject of the application—in cases of complaint the name of complainant, and the cause of complaint; in other cases, that of the patentee, the subject of the patent, and the number which the same has in the patent roll. The Treasury furnishes receipts only if expressly wished for; the cost of postage in such case to be borne by the receiver of such receipt.

PATENT JOURNAL.

The Patent Journal is intended for the public notices and publications required by the patent act. Accordingly, it will contain all publications relating to notices of inventions filed for the purpose of obtaining a patent, as well as to the refusing or granting of the patent, to the commencement, termination, expiration, declaring invalid, and the withdrawal of the patents.

The regulations made for carrying the patent act into effect, and such action and decisions of the Patent Office itself as are of general public interest, shall also be made public through the Patent Journal.

The right will be reserved besides of communicating in an unofficial column the more important transactions occuring in the field of patent matters.

Publications relating to the notices of inventions, to the refusal, to the granting, and the duration of patents shall be inserted in one column under the heading of "Patent List."

In addition to the main journal there will be published in separate supplements, to be circulated from time to time, and to be known at "Patent Documents," the drawings and specifications, on the strength of which the granting of the patent has ensued. The subscription price for the latter will be specially made public.

The publication of the Patent Journal has been entrusted to the publishing-house known here as "Carl Heymann, publisher."

The price for Germany will be twelve marks annually; for the first six months up to the end of the current year, five marks.

Berlin, July 12, 1877.

IMPERIAL PATENT OFFICE.

(Signed,)

JACOBI.

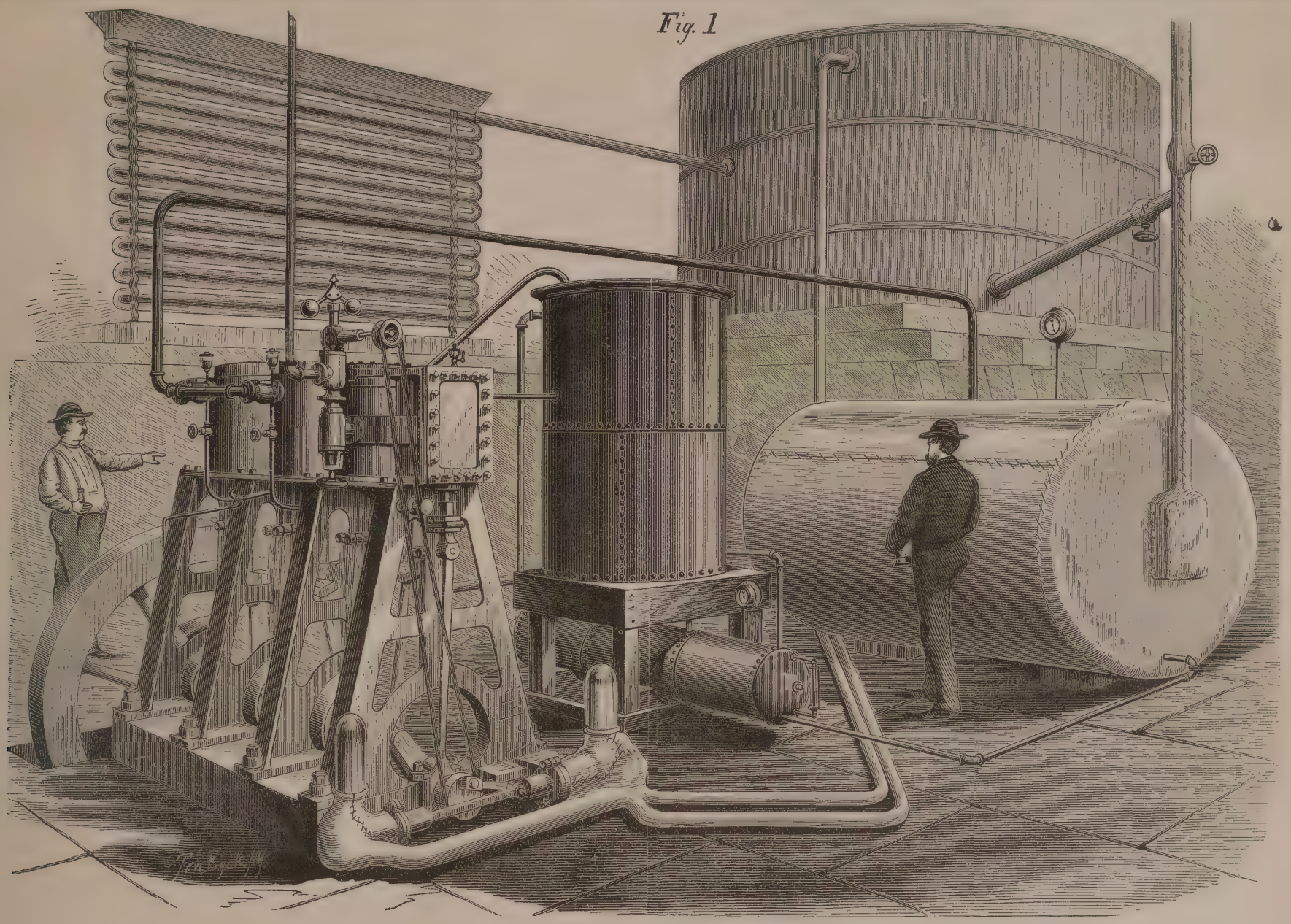
THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, SEPTEMBER 29, 1877. No. 13.

Fig. 1

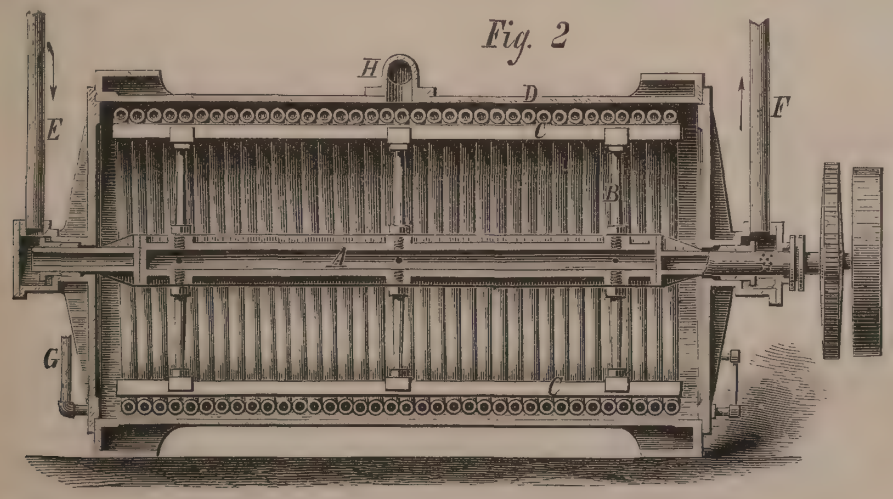


ICE MACHINES.

The advantages and desirability of ice machines need no further pointing out in this journal. We copy herewith from a descriptive circular, descriptions and illustrations of a machine* now in operation at Bergner & Engel's brewery in this city:

The machine is adapted to the use of any volatile liquid, such as common ether, methylic ether, chymogene, sulphurous oxide, etc., and works equally well with any of them. A perspective view of the whole apparatus is given in the large engraving, Fig. 1, while the details are represented in Figures 2, 3, and 4. The refrigerating cylinder is seen at the right hand side of the large engraving, and in section in Fig. 2. It may be made of any suitable material, while it is covered with felt or some non-conducting material. It is journaled on a longitudinal shaft, *A*, which is provided with radial arms, *B*, which carry upon their outer ends longitudinally arranged ribs, *C*. Around these ribs, and near the inner periphery of the cylinder, is wound a continuous coiled pipe, *D*, in which circulates strongly saturated brine or other non-congealable liquid, which is received from a convenient cistern or tank. A coil of pipe extends the entire length of the cylinder, and at each end communicates with the hollow ends of the shaft, *A*, and through this hollow with the supply pipe, *E*, and the exit pipe *F*, so that a continuous circulation of the non-congealable liquid may be kept up in the coil. Inside of this cylinder a volatile liquid is placed, which may be ether, chymogene, ammonia, anhydrous sulphurous oxide, or any other easily evaporated liquid, which is introduced through a pipe, *G*, and is maintained at such level as to immerse the bottom portion of the coil of pipes, which level may be regulated by means of a glass gauge upon the outside. As the coil of pipes is revolved by any suitable mechanism, the coil passes to the upper portion of the cylinder wiith its surface moistened by the volatile liquid, which it carries up from adhesive attraction; and as the cylinder is exhausted of its gaseous contents through the pipe, *H*, by means of the pumps seen at the left of the cut, Fig 1, the evaporation of the liquid upon the surface of the coil rapidly takes place to supply the partial vacuum, and a corresponding reduction of the temperature of the pipes and its contained vehicle of non-congealable liquid takes place.

Fig. 2



To guard against leakage, which would prevent the best action of the pump in effecting evaporation, the ends of the shaft, *A*, are provided with stuffing boxes, while the outer parts of the bearings are enlarged to form water boxes, which are filled with the non-congealable liquid, and these, together with the stuffing boxes, effectually seal the bearings against all leakage of air in the interior.

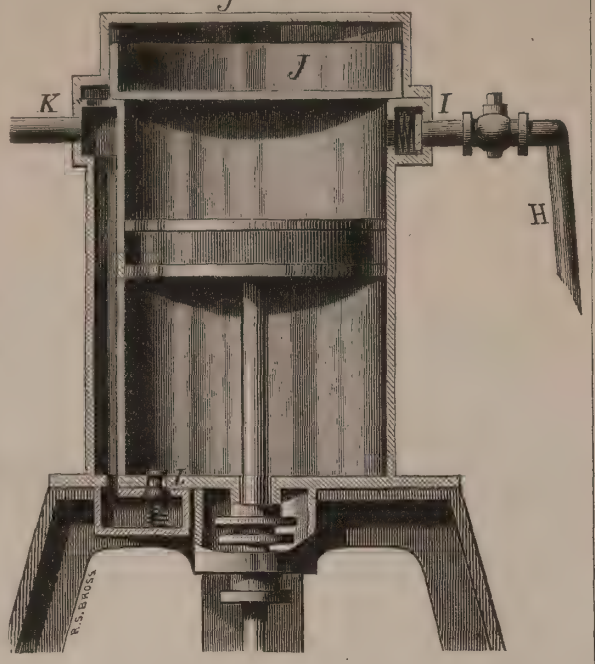
As the gas is exhausted from the cylinder, it passes to the pumps previously referred to, from thence to a condenser, seen in the centre of Fig. 1, and thence through a pipe as a liquid to a receiver which is shown underneath the condenser.

The cooled non-congealable liquid passes into the case, *M*, Fig. 4, through the pipe, *F*, and from thence back to the coil in the cylinder through the pipe, *E*. The circulating of liquid is effected through a circulating pump, shown at the foot and just at the right of the pump previously spoken of, which is operated by the engine at the right of the pumps, which also works the large pumps, refrigerator coil, and a rotary blower for circulating air in the congealing case.

*Made in the Penn Iron Works, Philadelphia, for D. L. Holden & Bros.

Fig. 3. The large pumps, of which there are two, are shown in sections, in Fig. 3, and are in fact the most important part of the apparatus. They communicate with pipe, *H*, from the cylinder through inwardly opening check valves, *I*, located in the branches of the pipe. These pumps are also provided with a gravity cup-shaped valve, *J*, which is of greater diameter than the piston cylinder, and plays between the cylinder head and the flange of the body of the cylinder, upon which it is seated, being guided in its movement by ribs in the enlarged cavity of the cylinder-head. In operation, upon the descent of the piston the gas is drawn through the pipe, *H*, the check valves, *I*, are opened, and the pump cylinder filled. But when the piston rises the check valves are closed, and the compressed gases above the piston lift the valve, *J*, and allow the gas to pass out into the pipe and from thence to the condenser through *K*. As, however, the gases contained in the portion of the pipe between the pump cylinder and the check are compressed, but not forced out, if the piston should descend with this pressure of gas retained here, it is obvious that the gas would expand, and, by partially filling the chamber, prevent the perfect exhaustion of the gas cylinder. To provide for this, the piston in its upward stroke passes the orifices of pipe, *H*, so that the compressed charge of gas is held in the confined space and is liberated beneath the piston, and upon its descent is driven out through the valve, *L*, at the bottom into a pipe that communicates with *K*. It will be observed that the face of the piston, in rising, strikes against the bottom of the cup valve and lifts it, and upon the reverse stroke the valve seats itself upon the flange of the cylinder, and while the plain ground face of the piston departs from the plain ground bottom of the valve it produces as nearly a perfect vacuum as is possible to attain in a pump, there being practically no cushion of gas left between the valve and piston.

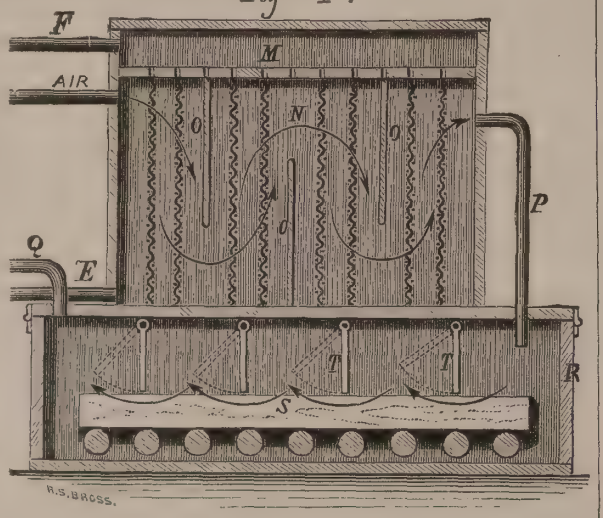
Fig. 3.



As the gas is delivered to the condenser it is made to traverse coils and is cooled by the circulation of water of the normal temperature which passes through the condenser. As the gas is liquified it passes into the receiver, where it accumulates and is fed into the refrigerator cylinder.

Fig. 4. As the non-congealable liquid in the coil of the refrigerator circulates, it passes out through the pipes *F*, to the distributing pan, *M*, Fig. 4, where its temperature is to be transferred to the air circulating in the subjacent case, *N*. The upper case is provided with a distributing pan, into which the cooled liquid is admitted. The bottom of the pan has perforations which are arranged in rows immediately above a series of vertical partitions of wire gauze, between which are arranged the vertical baffle plates.

Fig 4.



As the cooled liquid drops through the perforations in the pan, it falls upon the wire partitions, and being retarded in its descent, trickles slowly down, while the current of air driven through the case by the blower is made to pass through and penetrate all parts by reason of the baffle plates, and in so doing takes of the temperature of the non-congealable liquid, which is below the freezing point of water, and passes into the congealing case at and through pipe *P*, and then traverses the pans in the congealing case to freeze the water therein contained, and after having done its duty passes up through the blower and pipe, *Q*, to be reduced in temperature again.

The congealing case has doors, *R R*, at each end, and is provided with supporting rollers upon which the pans, *S*, are fed in at one end and removed at the other.

The apparatus if used for cooling liquids, as beer, etc., the liquid is allowed to trickle down over the coiled pipes seen at the left of Fig. 1. In a large brewery, where a contract required 560 barrels of water to be cooled from 60° to 38° Fahr. in 24 hours, which is equal to the production of 8½ tons of ice from water at 80°, the actual yield of this machine consisted in the cooling of 1,010 barrels of water, which is equal to the production of 16 tons of ice per diem. For this yield the machine required an average of 24 horse-power. The apparatus, as shown in Fig. 1, was taken from one in actual use in Philadelphia. It requires but the attention of a single attendant.

In this machine any volatile liquid can be used as before mentioned, and the operator has the choice to take that which suits him best under the circumstances. In order to give an idea of the field open in this direction, we insert a table of substances which may be used for refrigeration, and which was compiled from the most reliable authorities, and some new data determined by P. H. Vander Weyde, M. D., of New York, who has also largely experimented in this field and, for many years has been as well on theoretical as on experimental grounds, convinced of the final success of refrigeration by artificial means.

Name of Substance.	Boiling Point at Atmospheric Pressure in deg. Fah't.	Pressure of Vapor, in pounds per square inch, at 65 deg. Fah't.	Spec. gravity of Liquid at 40 deg. Water=1.	Spec. Gravity of Vapor at 40 deg. Air=1.	Latent Heat of Vapor by equal weight.	Relative Latent Heat by equal bulk of vapor.	Names of Iventors who used some of these substances.
1—Turpentine	311	0.9	0.86	4.6	133	611	
2—Water	212	0.3 lbs	1	0.45	990	447	Leslie, England.
3—Common Alcohol	173	0.8	0.80	1.26	385	485	
4—Chloroform	140	4.0	1.48	4.1			
5—Methyl. Alcohol	118	0.6	0.814	1.1	390	430	
6—Bisulp. Carbon	112	2.5	1.27	2.6	210	550	Paersh, New Orleans.
7—Comm. Ether	90	8.0	0.736	2.28	162	369	Siebe, England
8—**Chymogene**	**30 to 50**	**12 to 17**	**0.6**	**3.9**	**170**	**663**	*Van der Weyde*, N. Y.
9—Sulphurous Oxide	14	60	1.49	2.25			
10—Cyanogen	— 4	80	0.86	1.8			Tait, N. Y.
11—Methylic Ether	— 6	90		1.617	240	384	
12—Ammonia	—30	120	0.76	0.59	900	511	Tellier, France
13—Chlorine	—35	150	1.3	2.47			Carré, France.
14—Sulph. Hydrogen	—80	250	1.33	1.19			
15—Hydr. Chl. Acid	—100	450		1.26			
16—Carbon. Acid	—112	600	0.80	1.53	300	495	Lowe, N. Y.
17—Nitrous Oxide	—130	700		1.52	342	520	VanderWeyde N. Y.*
18—Air	15,000 lbs. pressure per square inch does not liquify it.						Kirk, England.

It is seen from this table that the liquids No. 1—6 have rather high boiling points, involving little cooling effect, while 15—17 have very low boiling points, involving strong cooling, but on the other side requiring immense pressure to condense them, hence for all attempts to use these substances for the purpose of refrigerating and making ice have practically been failures. If now we consider that Nos. 13, 14 and 15, have such strong chemical affinities for metals that they soon destroy the apparatus, it is seen that Nos. 7—12 are left, and with each of these more or less success has been obtained—the success depending more on the perfection of the machine used than on the substance itself.

CONDITIONS TO BE FULFILLED IN THE USE OF BELTS.

Special conditions of successful practice, within which is embraced the driving capacity measurable by the area of contact, and modified by the state of the pulley and belt surfaces, and adhesive used, which must not permit the belt to slip or stick; the proper material for and treatment of belts; the utmost contact or arc of enrollment on the pulley; the proportion of diameter of pulley and length and width of belt for best running; the least rounding of the pulley faces, and the greatest smoothness obtainable; the hair side of leather belts always to pulleys, as it is the smoother side, for what is lost in contact must be made up in strain, and because the stronger fibres lie nearest the flesh side, and should be preserved; the amount of adhesion or traction developed by the tension employed; the fastenings, which should be of the best; the disposition of the laps such that the motion of driving will run *with*, not *against* them; the employment of large pulleys, high speeds, and light belts; the careful putting on and skillful joining of belts; the running of them, slack as possible, in the upper fold or strip; the avoidance of tightness by excessive strain or binders, and of lateral straining, as in some quarter-twist methods; the introduction of fly-wheels, or like devices, for rendering the work of the belt uniform; the increase of driving capacity, for overcoming occasional resistances and starting frictions; the uniformity of belt section, and weight and texture of material; the straightness of edges for smoother running at high speeds; the employment of gum belt for elevators, or to run in moist or hot situations, or where uniformity of section, without joints, is desirable—in fact, in many places where leather is generally used, always avoiding twists, all devices rubbing the edges, and the contact with any solvent of gum; the adoption of leather covering for pulleys, by which 33 per cent. of adhesion is gained; the securing of strips to the outer edges of single belts to increase adhesion; the running of a belt atop of another to make it drive; increasing the speed of a belt, which may be as high as a mile in a minute and be safe and advantageous; the introduction of the devices for augmenting the tractive pull of belts; the utilization of belts for imparting and arresting motion; the substitution of "wrapping connectors" for gear, as in twist-belt arrangements, which do not overstrain the fibres; these and a multitude of other conditions, involving the essential elements of best practice, will be found on examination to be accepted and used by the numerous authorities quoted, and to which the reader is directed and assisted by a complete index, arranged especially for ready reference.—*From "Use of Belting," by J. H. Cooper.*

*Applied for Patent, 1864, but withdrawn and abandoned.

GALVANIZING IRON.

Of the numerous processes for protecting objects of iron exposed to the weather, from the rapid rusting to which it is, as every one knows, very susceptible, one of the simplest and best, consists in giving to the iron a coating of zinc.

The admirable protective virtue exercised by the zinc coating, has not only caused the extensive adoption of the process, and vastly increased the demand for the zinc coated products, but has likewise opened new avenues for the use of iron, for which its rapid deterioration under atmospheric influences, had practically debarred it, despite of its cheapness.

While not attempting the enumeration of its almost numberless uses, it may be generally stated, that it is very extensively used for covering iron wire for telegraphic and domestic uses; on sheet iron, for architectural purposes, (an application that appears to be rapidly growing in favor), roofing, etc.; for vessels, tanks, household and garden utensils of numberless forms and uses, for coating iron pipe for conveying water, for railings, etc., etc.

The common name of "galvanized" iron, given to articles thus protected, is generally considered to be a misnomer, inasmuch as it is liable to mislead the uninformed into the supposition that the coating is applied by galvanic means, but when the nature of the protective action of the zinc is understood, it will appear to be very appropriate. The term galvanized really indicates just what the zinc performs for the iron, namely, that it protects the latter from rusting, by its galvanic action. The superiority of zinc for this purpose over tin, is very decided. The rapid rusting of tin coated iron, where it is not additionally protected by a coating of paint (which must be frequently renewed), is a fact with which every one is familiar; while galvanized iron, under similar circumstances, will remain for years, practically unaffected. The reason is not difficult to assign. It is a fact well established, that two new metals in contact with any exciting liquid (water moisture answers the purpose), will generate currents of electricity, in short, will form, at the points of contract, a minute galvanic battery. The action of such a galvanic circuit, is to destroy by solution or oxidation, the electro-positive element of the circuit. When tin and iron therefore are in contact with moisture, the iron being electro-positive in its relations to tin, is rapidly oxidized; where zinc and iron, on the contrary, are in similar contact, the zinc is the positive element, and is oxidized, the iron remaining unaffected. The protective action of zinc upon iron is therefore, not simply due to the mechanical protection exercised by the coating, but has a positive and active cause in the chemical relations of the metals. With tin-coated iron, each of the numerous points where the coating is imperfect at the edges and over the surface, becomes the centre of an operation of active corrosion, by which the whole sheet is sooner or later destroyed. With the zinc coated iron, the zinc is destroyed, but the action is far less rapid than in the former case, owing to the fact that the electrical qualities of iron and zinc are so nearly alike, that they form, when united, an exceedingly weak galvanic couple, and in consequence, the galvanic action of the two metals is vastly less energetic, than when iron and tin, or iron and copper are united.

The operation of galvanizing, in general terms, is performed very much like that of tinning. The surfaces to be galvanized are first thoroughly cleansed of grease, oxide and other impurities, and the clean metal then immersed, for a brief period, in a bath of molten zinc, which suffices to effect the attachment of a sufficiently thick coating of zinc. The time of immersion must be carefully measured, however, in order to avoid a too deep penetration and alloying of the zinc with the iron, as in such case, the metal will be made too brittle. Where it is desired to have a frosted appearance of the galvanized wares they are rapidly cooled. Where the wares have considerable mass, as is often the case with castings, the cooling must be effected by plunging into cold water. With sheet iron or goods of sheet iron, the cooling need not be artificially hastened. When cast iron goods are allowed to cool normally the coating will be of uniform tint. Where wire is to be galvanized, a simple mechanical device is employed to pass the same through the zinc bath, at a uniform rate of speed. When sheet iron is to be treated, a similar device is frequently employed. A too rapid cooling of the goods after dipping, is to be avoided, as producing blistering of the zinc, and which, of course, seriously impairs the quality of the products.

To protect the vessel in which the zinc is melted, against the destructive action of the metal,; some manufacturers melt a small quantity of lead in the vessel, then add the zinc, which mixes very slightly with the lead, and being lighter than the latter, floats upon it. Gradually the zinc bath takes up so much iron, as to be useless for its purpose, and the bath must be renewed.

The process of galvanizing is a French invention, and was introduced into England in 1837, when a patent was obtained by Mr. Crawford. His plan was to plunge the objects, after cleansing in diluted commercial sulphuric or muriatic acids, into a bath of melted zinc, covered with sal-ammoniac.

By Mallet's method, the sheets are first cleansed by immersion in a warm bath of equal parts of sulphuric or muriatic acid and water, followed where necessary by scrubbing with emery and sand, or by the use of a scraping tool upon any portion of the surface where scale still adhers. They are then placed in a preparing bath of a saturated solution of hydrochlorate of zinc and sulphate of ammonia, from which they are removed to a metallic bath, composed of 200 parts of mercury and 1292 parts of zinc; the addition of one pound of sodium to ever ton of the amalgam, being recommended. At the temperature of 680° Faht., this mixture fuses, and the zinc is deposited on the iron, the alloying process taking place with such energy that the iron would be rapidly dissolved, if allowed to remain even for a few seconds. The operation, therefore, requires to be conducted rapidly and skillfully.

Concerning the details of the process as practiced in this country, as well as other points in connection with the industry, we add the following facts kindly furnished by Messrs. C. H. Horne & M. P. Breeding of the Phila. Galvanizing Co., where the writer was afforded ample opportunity for inspecting the entire operation, as conducted on the large scale.

The iron to be galvanized, is first immersed in a bath of diluted sulphuric acid, then washed in water. The articles are then passed to a workman, who removes any scale that may still remain on the surface, with a scraping tool provided for the purpose. After having passed his inspection, the iron is immersed in a bath of dilute muriatic acid, from which it is shortly taken and removed (without washing), into a drying chamber, on emerging from which it is ready for the zinc bath. The dipping process occupies about 10 to 15 seconds with sheet iron, and with cast iron objects somewhat longer. The acid and washing tubs, drying oven, and metal bath are so disposed with relation to each other as to make the several manipulations as continuous as possible without loss of time. The slight incrustation of chloride which remains upon the iron after it comes from the drying room, appears not only not to interfere with the zincing but to favor the operation. With every operation a trifling quantity of iron from the object immersed therein enters the zinc bath, and in course of time forms what appears to be an alloy of zinc and iron, which slowly accumulates in form of a spongy mass at the bottom of the pot, from which it must from time to time be removed with a shovel or scoop provided for the purpose, while fresh zinc must be added from time to time From this dross, the zinc, of which it contains a considerable percentage, is regained by sublimation, the practice leaving generally to dispose of it in quantity to smelters for this purpose. The processes here described, although simple, are quite interesting to observe, and require the exercise of good judgment and considerable skill on the part of the operatives.

W.

JOINING IRON AND STEEL WIRE.

In manufacturing guides for coal and other pits, colliery ropes, telegraph wire, telegraph cables and fencing, and in other manufactures, it is often necessary, in order to obtain wires of the required length, to join two or more lengths of wire together, end to end, and this is ordinarily done by the process of welding. But in welding together wire of iron or steel the metal is frequently so injured during the welding process that the junction formed is very weak, and the wire is liable to break at the welded part. The object of an invention of Mr. W. Hibell, of Birmingham, England, is to produce wires of iron and steel of any required length, having at the joined part a strength equal to any other part. He cuts away a portion of the end of each wire, so as to give it a semi-cylindrical figure, the said cutaway portion extending about one inch from the end of the wire. The extreme ends of the wires may terminate in planes at right angles to the axis of the wire, but he prefers to incline each end so as to give it a wedge shape, the thin end of the wedge terminating in the axis of the wire. When he thus inclines the ends of the wire, he makes the shoulder terminating the cutaway parts of an under cut figure, so that the wedge-shape end of one wire when the ends of the two wires are fitted together shall engage with the under cut shoulder of the other wire. The ends of the wire thus shaped he connects together by the process of brazing or hard soldering, and the junction formed has a strength equal to that of any other portion of the wire. In wires of small diameter he prefers to give to the ends to be joined a plane, making but a small angle with the plane in which the axis of the wire is situated. The two plane inclined ends are joined by hard soldering or brazing. Although in practice he has found that plans of about one inch in length formed on the wires answer very well, yet he does not limit himself to the use of these proportions.—*Coal Trade Journal*, *xiv*, 109.

LIGHTNING-RODS AND PROTECTION.

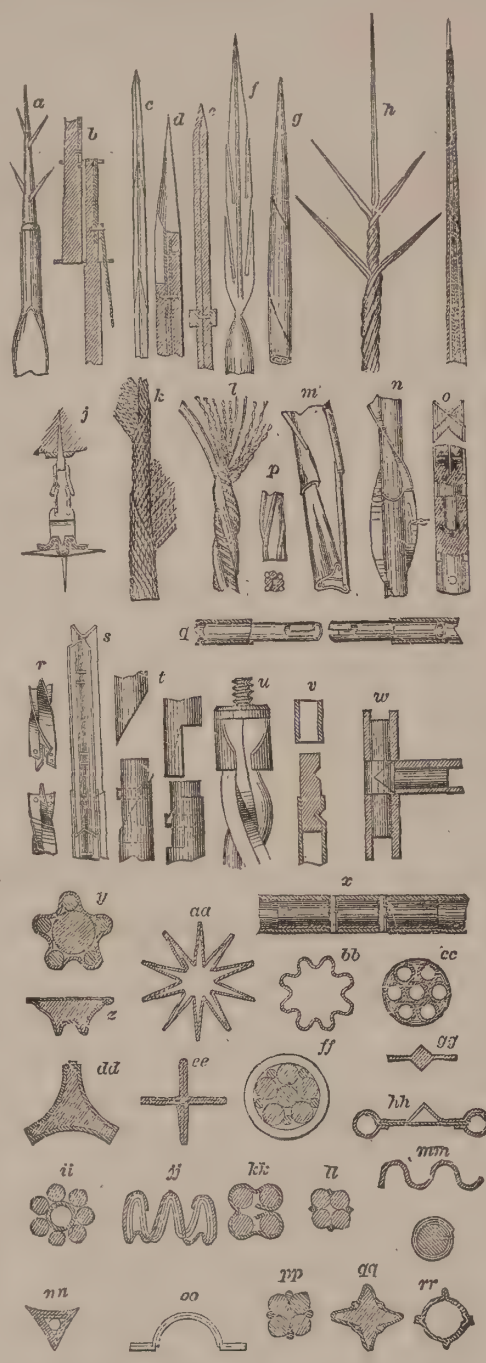
To Franklin is due the invention of a conductor by which the accumulated electricity existing in the atmosphere can be discharged or brought into equilibrium. Since his day the subject of lightning protection by means of metallic conductors has engrossed the attention of both our own and of foreign electricians. Though governments have appointed committees to investigate the subject, time and time again, they have only succeeded in complicating a very simple problem, and have in no way increased the efficacy of the simple rod and earth-terminal as devised by Franklin.

Lightning, so called, is the discharge or union of the electricity of the atmosphere and that of the earth; the former being caused by a combination of circumstances, such as the evaporation of water from the earth's surface, the condensation of vapor, the unequal heating of the earth by the sun's rays, by combustion, and by the friction of winds against each other and the earth's surface. This electricity is generally positive, and consequently induces electricity of opposite character in the earth. It is the union of these two kinds of electricity to neutralize each other that produces the lightning discharge. Such a discharge will always take place where it finds the least resistance; hence the object of establishing a path of good conducting material to lead the discharge directly into the earth, and not through the house and its contents. The function of the lightning-rod is simply explained as follows: when a storm-cloud positively electrified, for instance, rises in the atmosphere, it acts, as already stated, inductively on the earth, repels the positive and attracts the negative fluid, which accumulates in bodies placed on the surface of the soil, with greater abundance as these objects are higher. The tension is, then, greatest on the highest bodies, which are, therefore, most exposed to the electric discharge; but if these bodies are provided with metallic points, like the rods of conductors, the negative fluid, withdrawn from the soil by the influence of the cloud, tends to flow into the atmosphere, and neutralize the positive fluid of the cloud. Hence, not only does the lightning-rod tend to prevent the accumulation of electricity on the surface of the earth, but it also in a measure tends to restore the clouds to a state of electrical equilibrium, and thereby prevent a discharge. When the disengagement of electricity is so abundant that the lightning-conductor is inadequate to discharge the ground, a violent discharge takes place, or the lightning "strikes;" but the conductor receives the discharge, in consequence of its lesser resistance, and the building is preserved. Since the path thus furnished for the discharge should of necessity be as good a conductor as possible, the metallic roof, water-spout and gas-pipes of a building should be well attached to each other and to the lightning-rod, in order that the electric equilibrium of the roof and building should be readily restored. Not only should the gas-pipes, if in great number and of large size, be well connected with lightning-rod, but it is even as important that the meter should have a good earth-connection, for in case the lightning should pass down the gas-pipe (often happening where the earth-connection of the rod was imperfect), it would, if no connection were made, experience so much resistance in its passage to the earth as to ignite the gas and building by the heat generated. It is claimed by the most competent authorities that the erection of a vertical rod firmly attached to the metallic roof, and this with the rain-spout (made of thick tin or terne-plate, tightly fitted and soldered

together), connected with a good earth-terminal, would (as experience has shown) form an easy and thoroughly protecting lightning-conductor.

The custom of tipping the point or points of lightning-rods with gold, silver or platinum is as useless as that of insulating the rod from the building is fallacious; for the quantity of rust which would accumulate on the points would in no wise appreciably affect the conductivity of the rod. In fact, an authority on the subject claims that points are altogether useless, since the storm-clouds are generally so far from the earth that the air-terminals of the rod would be incapable of restoring the electrical equilibrium of the cloud and earth quietly and without a discharge, as claimed by some electricians.

For the sake of curiosity rather than the purpose of pointing out the efficiency of any particular form, we give the accompanying illustration of some of the rods sold in this country, omitting, however, the "special" advantages claimed by the inventor of each.



a consists of five points of spiral rods affixed to a tube which forms the tip. As a conductor a flat band is used.

b represents a tubular conductor for use on vessels. At the head of the lower mast the conductor is divided, one branch leading down on either side of the shrouds to the water.

c is a grooved iron rod with a gilded copper tip.

d consists of a copper slip enclosed between iron side pieces interposed by zinc plates at the point.

e consists of a grooved iron rod to receive a copper slip, to which it is joined by screw-threaded washers.

f is a barbed point with opposite wings.

g consists of a spiral copper tubing, tapering off to a point.

h is a wire rope, of which the ends are tapering off to a point.

i consists of several metals, one inside the other, with the most fusible on the outside.

j is an iron bar attachment, with additional conductor-points at the coupling of the rod sections.

k is a copper cable consisting of a wire rope with two strands wound in opposite directions about it.

l consists of two copper wires intertwined with two iron cables.

m is a metallic tube of short sections joined together.

n is a corrugated tube with spiral flanges.

o. The joints of the rod are coupled by cross-shaped pieces, and are secured by rivets of bolts.

p consists of a wire worming around four twisted rods.

q are short inside slotted pieces forming a species of bayonet point by which the rod is joined and held by a pin.

r consists of two strips of sheet metal riveted together at their angles and twisted spirally.

s represents the slotted ends of sections through which a pin is passed to fasten them together.

t. The sections are connected by interior short pieces secured by a pin.

u. The cable consists of a flanged spiral, and the sections fastened together by a dove-tailed coupling-screw.

v consists of a square tubular rod, of which the sections are secured together by indenting the tubes into slots in the plugs or by riveting them.

w. The sections are coupled by an interior cylinder and a tapering plug projecting from each of its sides.

x is an interior tube with pins to hold the ends of the tubular sections together.

y to *rr*, inclusive, represent vertical sections of various kinds of patent rods, each possessing some imaginary virtue.

Very few of the lightning rods now in position can be relied upon to furnish a path for a lightning discharge, since but few have efficient earth-terminals, the same being either of too little metal, or are placed in dry soil. Most of the earth-terminals are formed by simply sticking the end of the rod into the earth at the base of the building. Little wonder that the lightning passes to the earth by means of the gas-pipes in preference!

The attaching of the conducting wire to a sewer-pipe, or to a mass of metal buried in the earth, is not sufficient if the earth be not moist and of a good conducting nature. The terminal should be situated, if possible, beneath a subterranean water-bed or in earth that is constantly kept moist by waste or rain water.

Mr. H. W. Spang, in his admirable treatise on lightning protection, recommends the termination of the lightning conductor (formed either of a separate rod or of the metallic roof and water-spouts of a building) in a cast-iron pipe not less than ten feet in length, and having one or more perforations opposite each other in its side, placed vertically in the earth not less than eight feet from the foundation-wall of the house, and so arranged that the waste-water from a hydrant or pump and the rain-water from the spouts shall empty into it, and thereby constantly keep the soil in a moist condition.

O. C. W.

UNDERGROUND TELEGRAPHY.

CRITICISMS AND COUNTER-CRITICISMS.

The Philadelphia *Ledger* says: "Underground telegraphy was the subject of much discussion and some disputes a few months ago, when a change in the office of the Western Union Telegraph Company, in this city, seemed to offer a favorable opportunity to lay underground wires. For some reason the plan does not advance rapidly in this country, although there are lines laid underground in many of the larger cities of Europe, and the underground system has been adopted for some long lines through the interior, where expensive arrangements for the repair of broken or disarranged wires cannot be made. A line was laid underground between Berlin and Cologne as early as 1848, but proved a complete failure, owing to the presence of sulphur in the gutta-percha with which the wires were covered, and which destroyed the gutta-perch. That failure brought subterranean telegraphy into disrepute, and for 25 years few attempts were made to lay underground cables on a large scale. At present, however, Germany has seven underground lines between its capital and its western frontier. A line between Berlin and Mayence, passing through Halle, Leipsic and Frankfort, has been recently completed. The wires are twisted together and covered with hemp and iron, and the cost is about six times as great as that of the same number of overground wires would be. This line is 600 kilometers, or about 372 miles in length, and no doubt is entertained that it will work well. A short underground line is being laid, we understand, in West Philadelphia, with the aid of all the protective devices developed by experience."

Commenting upon these remarks of the *Ledger*, the *Iron Age* speaks as follows: "The *Ledger* does not seem to understand that telegraph wires laid underground are very like ordinary submarine cables, and very serious retardation takes place in them. The open-air lines are the best, and the higher they are from the ground the more satisfactory their working. It will by no means be a blessing to the public to have the wires buried, as in the end it may materially increase the cost of telegraphing. The true remedy is probably in the direction of larger poles, stronger wires, with better conducting power, and finally, placing the poles further apart."

With this opinion of our contemporary we must take issue, with some surprise that a journal generally so well informed as *The Iron Age*, should advocate an aggravation of the evils of the post system, which all progressive telegraphic engineers agree in pronouncing to be imperfect in the extreme. We do not understand why the retardation of the current should be greater in a insulated line laid a few feet below the ground, than in an aerial line. On the contrary, we can very well understand why the underground line should have decidedly the advantage of the aerial one, in that by the use of the proper precautions that experience has taught, such lines may be insulated far more perfectly than it is possible to insulate the air lines, which, during the continuance of storms, it is impossible to work for days at a time; while the occurrence of even a rain of a few hours, may exercise a notable influence on the conductivity of the line.

The difficulty which our contemporary designates by the term "retardation," probably refers to the evil of local induction, which was for years the bugbear of the advocates of the underground system, but which has of late years, by notable improvements in the methods of insulation, been almost perfectly overcome.

The underground system furthermore is free from other aggravations that the aerial line is subject to. It is not interrupted by the breaking of wires, or falling of poles, by accumulations of ice or sleet in winter; and its freedom, at times of imperative necessity for safety of life and property from the violence of the mob, which late experience in our country has taught us to look upon as a serious calamity, is shown by the fact that in Paris, during the reign of the Commune—when almost every institution of public utility was sacrificed, the underground lines were *not* disturbed —"out of sight, out of mind."

We need say nothing here of the disfigurement of the highways and the streets of cities with posts which no amount of ingenuity can make attractive; nor of the decoration of wires with the skeletons of what were once hoop-skirts and kites, and with divers other things unsightly and unsavory; nor of the obstruction they frequently make to the use of fire-escapes and ladders in cases of fires; nor of the occasional loss of life, where the sagging wire jerks the unsuspecting equestrian from horseback into eternity, or the rotten post (*æquo pulsat pede*) impartially knocks out the brains of whoever happens to be passing; nor of the ease with which wires may be cut and communication interrupted by bad men for villainous purposes. These things taken singly do not seem to be such very serious objections—but taken collectively they seem to us to be enough to damn any system, when a substitute is at hand which is not only free of all these objections, but is superior in every other essential respect.

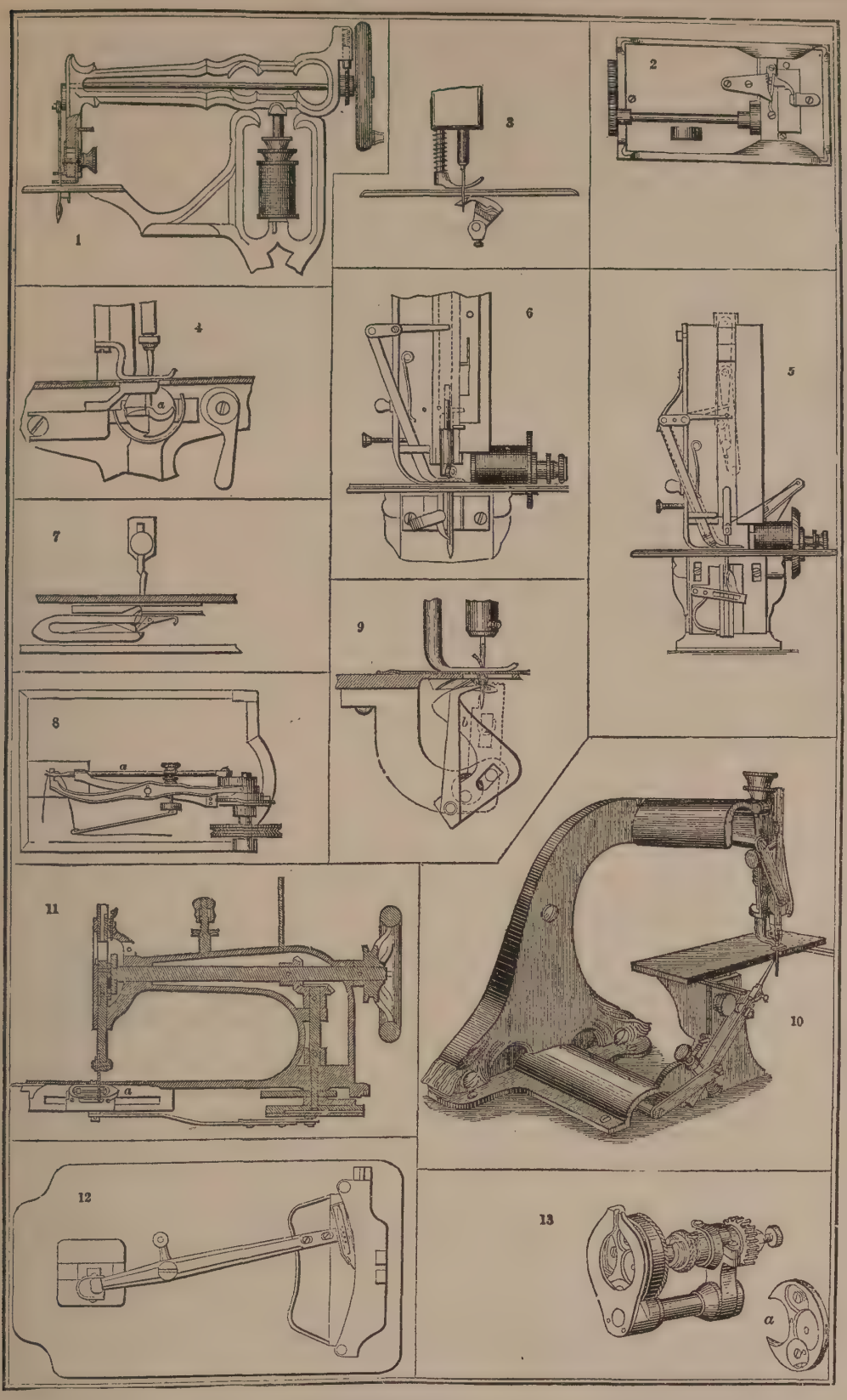
The chief objection to the underground system appears to us to reside in its first cost, which is considerably greater than that of the aerial system in vogue; but this objection, we are convinced, will be far more than counterbalanced, where the line is properly laid, by the very trifling cost of its maintenance, an item which makes a large figure in the annual expense account of overground lines.

It is doubtless true, as stated in the *Ledger's* artiele, with which we lead out this criticism, that subterranean telegraphy was brought for a number of years into disrepute by the failure of many of the early experiments that were tried abroad, but it is also none the less true, that there are lines of underground telegraph at present in perfect working order that have been constantly operated for 25 years, and that the difficulties of insulating the wires so as to prevent the serious danger of local induction and the grounding of the line, and so as to last for years, difficulties which at first appeared quite beyond a practical solution, have been successfully obviated. These questions no longer enter into consideration on the continent of Europe; and when we add that the German Government passed a law some time since, that in future all the lines of the Empire should be underground, we are not risking much in affirming that the underground system is *un fait accompli*: to which affirmation we will add, without assuming to be a prophet—that it (or the cable on the ground) is to be the telegraphic system of the future.

It is rather curious, in conclusion, to note the fact that even the technical press of the United States, in speaking of the underground system, speak of it as an experiment, which has met with but questionable success abroad, seeming to be quite ignorant of the fact, that in Germany, the Netherlands, Switzerland, France, Austria, and England, there are hundreds upon hundreds of miles of such lines that have been in constant and successful operation for years. To Germany, however, belongs the credit of giving the first real impetus to the general adoption of the system for lines of considerable length through the country, by the construction of an underground network connecting the chief cities and fortresses of that country.

W.

THE PRINCIPLES OF ACTION OF SEWING MACHINES.*



I.

The Sewing-Machine is no exception to the ordinary rule, that an invention is a growth rather than an inspiration. Elias Howe seems to have set himself to the problem in 1843; in 1844 he devised the curved needle and interlocking shuttle; in May, 1845, he had a machine at work. In 1846 it was patented. There-after the struggle in the United States and England was to obtain funds for manufacture, and many weary, hungry days were passed by the indomitable inventor. He sold various shares of his invention from time to time, but when the tide truned in his favor, he re-purchased the rights, and soon made a compact property of it. It was not all smooth sailing even then; but the parties disposed to dispute his broad claims were induced to come under agreement of tribute or of neutrality. The original claims which concerned the eye-pointed needle and shuttle gave coherence to the confederate parties. The bond of union has since been the mode of feeding. A. B. Wilson's four-motion feed is so superior to all others, that but few first-class machines are made without it.

Without impugning the genius of the earlier inventors, it may fairly be said that the present proximate perfection of the machine is due to the men who took up the work where Howe left it,—to Singer, Wilson, and others. The plate illustrates the principles of action of the various types of machines.

SINGLE-THREAD CHAIN-STITCH MACHINE.

1. The bearded needle pierces the cloth and draws up the loop from below; the cloth is then fed, the needle retaining the loop, which enchains the thread.

2. The loop formed by the eye-pointed needle is seized and distended by a reciprocating loop-taker, until penetrated by the needle at its second descent.

3. Similar to the above, excepting that loop-taker vibrates.

4. The loop-taker *a* rotates. The Wilcox & Gibbs pattern.

5. The looper is operated by the pressure of the needle, retreating before it and seizing the loop as the needle returns.

6. Needle-loop caught by a stationary hook that detains the loop as the cloth is fed, the next descent of the needle passing through the loop.

7. Latch-needle, for enchaining or knitting the loop. [See stitch 6, plate of stitches in REVIEW, page 25.]

TWO THREADS.

8. The loop of the needle-thread interlocked by the thread of the reciprocating looper *a*. See stitch 13.

9. Similar to the above, but having a vibrating looper *a*.

10. Two needles penetrate the fabric from opposite sides. [See stitch 16, page 25, of current volume.]

LOCK-STITCH BY SHUTTLES.

11. The loop of the needle-thread interlocked by the reciprocating shuttle *a*. Singer pattern. See stitch 19.

12. Similar to the needle-thread; shuttle vibrates in an arc of a circle. Domestic pattern.

13. The shuttle *a* is stationary, and the loop of the needle-thread is passed over it by a vibrating arm *b*.

Beside these, there are machines which make a lock-stitch by means of revolving hooks, and also such special forms as are adapted to leather and sole-sewing, which will be described in our next.

*The illustration and the description thereof is copied from *Knight's Am. Mech. Dictionary.*

USE OF FILES.

You cannot sharpen a saw as you can a file; hence you should economize with it by using, when new, upon brass or upon cast iron, and afterwards on wrought iron or on steel, which do not demand such sharpness. To use a new file upon the hard skin or scale of castings is wasteful. The rougher the file used on a given work, the greater the economy, *in files*. Vise jaws are good to ruin file teeth on. One of the chief faults of the file is its lack of that "guiding principle" which the plane and the saw possess. As each tooth does work proportioned to the pressure put upon it when it is brought to the attack, it follows that it is necessary to give each tooth an even pressure equal and similar to that given each to the others.

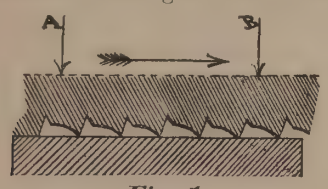


Fig. 1.

Fig. 2.

In the cut, Fig. 1 shows the action of file teeth; there being two forces—one a pushing and the other a pressing force. To cause each pass to make a straight cut, parallel to the last, it is necessary to keep the pressure, *A* and *B*, equal. In cutting a narrow surface, as in Fig. 2, this is rather difficult, as there is no "guiding principle," and there is a tendency (supposing the handle to be in the right hand, and the point pressed down by the left,) to rocking; the right hand being too strong at the beginning, and the left at the end, of the stroke. (This rocking is, of course, exaggerated in the cut.) The edge will be apt to be filed rounding; and to prevent this it will be necessary to vary the actual pressure of the hands in inverse ratio to the varying leverage, so as to make all the teeth cut equally. In filing floor plates, there is an advantage in having a slight convexity in the length of the file, thus giving the opportunity to reach high spots by local pressure of the left fingers on the belly of the file. The back stroke should be devoid of pressure. "Elbow-height" is the best for average work to be fixed; heavy work demands a lower position, so as to permit of more weight being put on the file. To prevent these edges from "skinning" a file (ripping off its teeth), they should be worked diagonally or lengthwise. Oil or chalk prevents "pinning," or clogging of the teeth. Good filing is the finest test of mechanical skill and dexterity—and is very scarce. G

BAD RIVETING.

Although there has been so much said concerning steam-boilers, we might be allowed a few words more on the subject. Sometime ago, having occasion to use some boiler castings with tube-sheets attached, we started to take the sheets off, commencing by chipping, but finding, after a time, that we could save labor by hammering the rivet-heads, the result was about, on an average, *three blows with a pound and a half hammer* per rivet, to drive it completely away from its head.

Now this is what might be called bad riveting, and it was perfectly new, having never been used. The result of a high steam pressure, on such work, may readily be imagined. And yet we do not know that there are not hundreds of boilers in nearly the same condition, running very nearly up to their full capacity. Even though the work may not be so bad when new, corrosion will make it constantly worse, when leaks may start, and caulking is of no use; nothing but new rivets will answer. The rivets under discussion, were cut too short in the first place, and consequently the heads were under the proper size; then they were hammered too much, and a crack started around the head, and the whole structure of the iron ruined, as could be seen by examining them after they were removed.

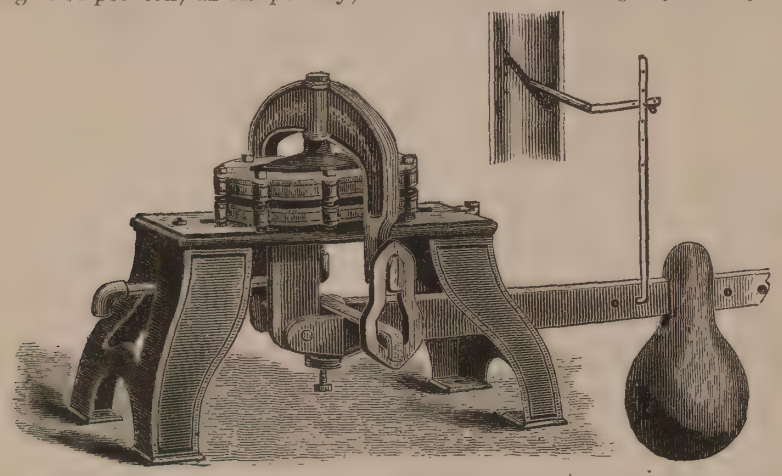
A good plan to prevent flawing the head in such a manner (in addition of course to good work), would be to counter-sink the holes in the sheet on the side of the heading, so as to form a fillet under the head, which would serve the same as fillets in castings, to avoid cracks. E. P. T.

AUTOMATIC DAMPERS FOR STEAM BOILERS.

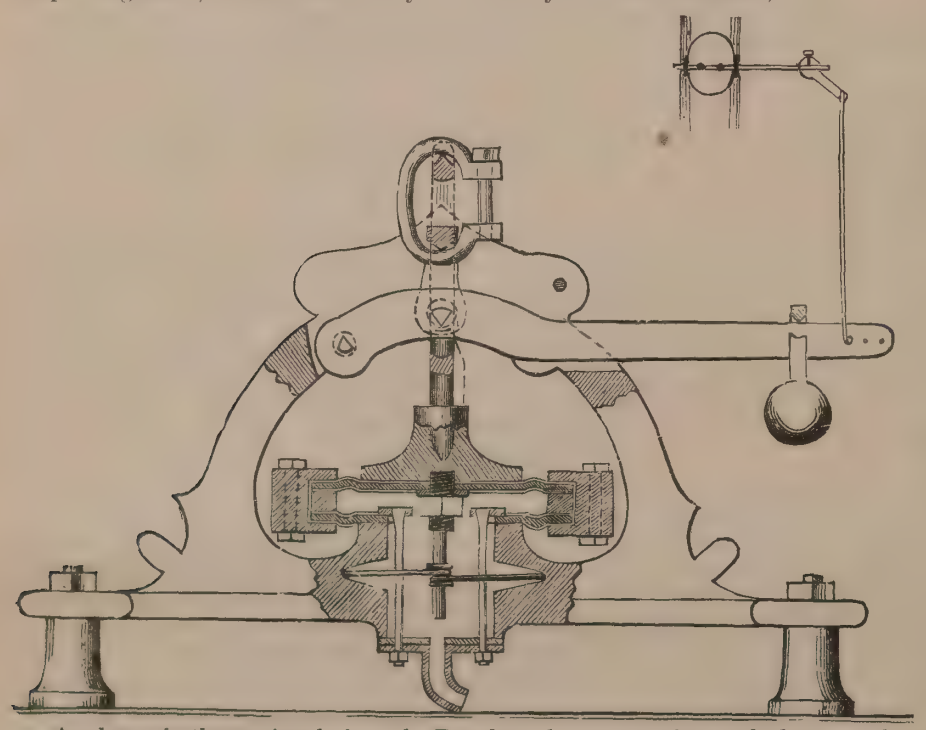
There are two things essential, among others, in the use of steam-boilers: that the combustion be regular, and approximately perfect, and that its amount be proportioned to the amount of steam used. The first point is gained by the use of such boilers and settings as will permit the entrance of air in such place, manner and quantity as to insure the thorough mingling and combination with the carbon and hydrogen of the fuel.

There are few settings that accomplish or permit of such favorable results. The second point has nothing to do with the setting, and is gained by putting a governor upon the boiler to limit the furnace, and supply in direct proportion to the amount of steam used and needed; just as the governor attached to the engine limits the steam admission in direct proportion to the amount of steam needed. The many advantages of a steam engine governor to control the steam admission automatically, needs hardly any rehearsal here. This control could not with safety or economy be entrusted to or be effected by hand. Now if it be desirable, even essential, that the steam admission be automatically regulated, is it not of almost equal importance that its generation be automatically regulated in precise accordance with the demand? But in four cases out of five, perhaps in a greater proportion, the governor of the engine is saddled with the work of atoning for the short comings in boiler regulation. The draft left to the attention of the fireman, is undiminished as the steam pressure rises; steam is blown off and wasted, before the damper is turned, and it continues to blow off for some little time until the combustion diminishes. Meanwhile the governor (as if it had not enough to do, to throttle more closely or to cut off earlier, whenever a machine is thrown off, or is eased of its work) is compelled to further cramp the admission, or to cut off still earlier, on account of the increase and unneeded steam pressure. When the boiler pressure runs down, it may happen, that the work to be done by the engine is at its maximum, perhaps live steam is required for heating or other purposes; and we find that the engine governor, while it can cram or cut off the steam supply, *cannot make steam;* cannot open the damper. There are many kinds of work, (rubber making for instance), where the loss from shortness of steam or power, is not confined to the time of the workman, but material is spoiled by waiting. The moral is evident: *the boiler must have a governor of its own*, to regulate the air supply, (and consequently the combustion) in direct proportion to the steam demand, and keep the steam at about a constant pressure, and hence aid the engine governor in the work of economy. If there be but one per cent. economy in the use of an automatic damper regulator, it should warrant the expense.

The Garner mills at Cohoes, N. Y., burned 28,000 tons of coal last year, when one per cent. on this would be 280 tons, worth about $1,120. A saving of one per cent. in full only in the case of an ordinary boiler consuming three tons of coal per day would be (rating at $4 per ton) 12 cts. per day, or $36 in the 300 working days of a year.



The cuts which accompany this article illustrate the Woodruff Patent Balance Damper Regulator, as manufactured by W. E. Kelly of New Brunswick, N. J.



As shown in the sectional view, the Regulator has an opening at the bottom which is connected by means of a pipe to the boiler. As the pressure in the boiler rises above the given point, at which the Regulator is set, two flexible diaphragms are forced upward and thereby raise the weighted lever, which by means of a bell crank and suitable rods closes the damper and checks the combustion in the furnace, and at the same time prevents the gases from going to waste by ascending the chimney, as is the case where the combustion is alone checked by the opening of the furnace doors. Since these regulators are set at a certain pressure, they at once indicate any fault which may exist in the registering of the steam gauge. The diaphragms are circular pieces of rubber packing, and can be inserted without any difficulty. Fig. 2 represents the improved form of the Regulator.

G.

THE VALUE OF SULPHATE OF IRON AS A DISINFECTANT.

We pointed out in a preceding article* the peculiar properties of that most admirable disinfecting agent, chloride of lime, and indicated briefly therein the conditions under which it could be employed advantageously or otherwise. Next to this substance the most commonly employed disinfecting compound is the sulphate of iron, (green vitriol, so-called "copperas"), and the brief consideration of its virtues in this regard, which we give in the following paragraphs, will be sufficient to demonstrate that, like the chloride of lime, it is by no means a universal panacea, and that its sphere of utility, though quite important, is limited. The contrasts between the situations in which these two disinfectants are found to be serviceable, is very marked, and this circumstance we esteem to be of special value for the purpose of this sketch, in distinctly showing that every substance which possess disinfecting virtues has its own special and limited field of usefulness, outside of which it is comparatively useless. The practice of many tolerably well informed persons of employing disinfectants indiscriminately, during the prevalence of an epidemic, or for the suppression of a nuisance that has become unendurable, often reaches to the absurdity of using several disinfectants at once, which may practically neutralize each other's virtues; the prevalent opinion being that wherever disinfection is demanded, the disinfectant that is most available at the moment will answer the purpose as well as any other, and that the matter of most importance is to use plenty of it. The grave errors of such opinions will appear very manifest in the course of our considerations.

The sulphate of iron, first of all, unlike the chloride of lime, is *not* a hygienic disinfectant. Although it is poisonous to the higher forms of life, there appears to be no evidence that it acts destructively upon the lower forms of organisms, as does the chloride. It is true that it has been employed for the preservation of timber, but its virtues in this regard, while they are shared by many other salts of the heavy metals, are at best very questionable, and even if admitted to be excellent, may be explained to depend mainly (or entirely) upon its property, (likewise shared with numerous metallic salts), of coagulating the albuminous constituents of the sap. One of the best illustrations that can be offered to prove conclusively that the sulphate is not a poison to the minute life forms, developed during putrefaction and decay, is afforded by the strong disposition of our common writing inks, most of which contain it in quantity, to become mouldy, such mould being, as is doubtless well known, a fungus vegetation, which often appears on bodies in process of decay.

The virtues of the sulphate as an hygienic disinfectant, therefore, having been shown to be at best very questionable, it remains to consider its value as a chemical disinfectant, and here its utility comes out strongly. Unlike the chloride, again, the addition of the sulphate of iron to cesspool accumulations will be found to be very serviceable, and can be strongly recommended. The most offensive odors emanating from such refuse may, by its judicious employment, be completely suppressed. The pungent carbonate of ammonia, which is evolved in volumes from such refuse, is speedily converted by the sulphate of iron into the sulphate of ammonia, a fixed compound which is odorless, a carbonate of iron being formed in the operation. This carbonate, as well as the excess of sulphate of iron, coming in contact with the offensive sulphuretted hydrogen and sulphide of ammonium, which are always present in quantity, gives rise to the formation of a sulphide of iron, the ammonia becoming fixed as before. In some such manner as this, therefore, the sulphate effects the breaking up of the offensive gases generated from decomposing fœcal matters, and converts them into compounds that are fixed and odorless. Certain organic acids of an obscure nature, and of comparatively feeble volatility, (and therefore but slightly offensive, save during the operation of cleansing), alone remain unaffected by its presence.

Unlike the chloride again, the action of the sulphate of iron upon such excremental matters, considered with reference to their subsequent utilization for fertilizing purposes, is not only not injurious, but, on the contrary, quite advantageous, inasmuch as its action is to fix and retain in a form available as plant food the most available fertilizing ngredients, namely, the nitrogenous components of the mass, which would ordinarily be lost by volatilization. It is true that the sulphate of iron itself, and the sulphide of iron which results from the operations above described, are both very undesirable ngredients of the soil, the first being poisonous to vegetation, and both by their oxidation depriving the roots of the plants of oxygen, but the oxidation of these compounds, when thus exposed upon the porous soil, goes on very rapidly; and the evils here detailed are trifling, when compared with the offsetting advantages of the greatly increased value of the manure, resulting from the saving of the rich nitrogenous elements. The sulphate of iron, also, has no injurious action upon the materials of the reservoir.

For the purification of the air of apartments by fumigation, the sulphate of iron, not being a volatile substance, is manifestly quite unfitted; while for the disinfection of the walls, floors, furniture, hospitals or sick rooms, or of bedding, clothing, &c., &c., it is not suited, from the fact that the surfaces with which it is brought into contact would become defaced or ruined by the rust which its oxidation would produce.

From the foregoing considerations, therefore, we may designate the virtues of the sulphate of iron, for disinfecting purposes, as follows: It is not a hygienic disinfectant, since it does not destroy the lower forms of life. As a remedy, therefore, against the spread of epidemic diseases, which spread by the dissemination of the germs of such minute organisms, it is quite useless.

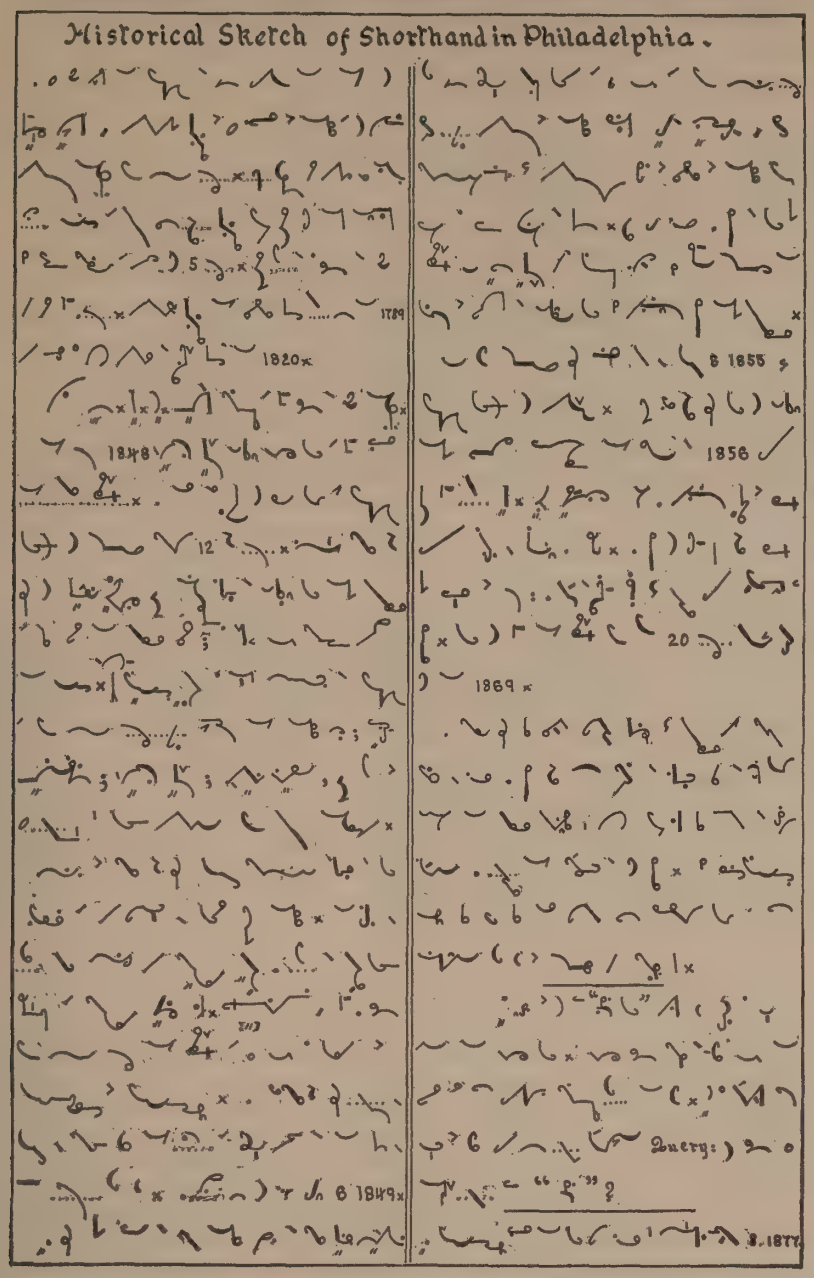
As a chemical disinfectant, however, for the suppression of offensive odors, affecting the question of comfort rather than health, it is a most excellent agent. Wherever the ordinary system of a walled reservoir for holding excremental matters is in vogue, and where, as is generally the case, the reservoir is but seldom emptied, the air of the vicinity, especially during periods of low barometer, will be charged with pungent and offensive odors. These may be effectually checked by the periodical addition of the sulphate in solution in water.

We may reserve a consideration of other disinfecting agents for future articles.

W.

*Vide page 138 of last issue.

"TRANSLATION" OF THE PHONOGRAPHY PRINTED IN AUDATYPE.



HISTORICAL SKETCH OF SHORTHAND IN PHILADELPHIA.

The first shorthand writer in Philadelphia, of whom we have any knowledge, was Thomas Lloyd, who reported the debates in the first Congress of the United States, and was legal reporter in the city for many years. During this time, he returned to his native land (England), and published some of the debates, for which he was thrown into Newgate as a political prisoner, and remained there five years. He was the author of a system of short hand, which he taught here. Reports of debates in the House of Representatives, taken by him in 1789, are extant; as also, reports of trials taken in 1820.

Later, Mr. T. C. Gould practiced and taught a system of shorthand, in this city.

In the year 1848, Oliver Dyer introduced Pitman's phonography, and taught a class in the Boys' High School. The influence of his teaching was soon felt, and the Philadelphia Phonographic Society was organized April 12th of that year. Among the members of that society, was Townsend Sharpless, who was an enthusiastic advocate of introducing phonograpy into the public schools, and of its use in business houses: an idea now practically realized in England; also, Franklin Peale, a noted mechanician of Philadelphia, and for many years Chief Coiner of the United States Mint; Clinton Gillingham; Oliver Dyer; Robert Paterson, who was the author of the first book on Phonographic Reporting ever published in this country.

Many of the members of that society have been prominent advocates of phonography ever since; and are well known to phonographers throughout the United States. In addition to those above mentioned, are Professor Booth, the author of "Booth's Phonographic Instructor," and Prof. James A. Kirkpatrick, who taught the system for many years in the High School, and is now an officer of the Phonetic Shorthand Section of the Franklin Institute. The efforts of the members of that Society appear to have been to perfect themselves in the art, and there is no record of any attempt to go further than that. The last meeting was held June 6, 1849.

The society had the honor of numbering in its list of members, Dennis Murphy, than whom there is no better phonographer, and who is now, and for many years has been, the chief reporter in the United States Senate; and John McElhone, who has been permanently connected with the reportorial staff of the House of Representatives of the United States for nearly an equal length of time. These gentlemen commenced the study of phonography at the High School, under Mr. Dyer, which fact alone is a strong argument in favor of the utility of introducing phonography, as a regular study, into the public schools.

No other organized society existed up to February 8th, 1855, when the Philadelphia Phonographic Society was revived. Through the efforts of this society, phonography was introduced into the Girls' Normal School in the spring of 1856, where it was taught by D. Shepherd Holman, until the regular teachers of the school were competent to continue the instruction. The study was thrown out of this school at the close of the year, the Board of Controllers considering that the pupils were overcrowded with studies. Phonography was taught in the High School for over 20 years, being abandoned there in 1869.

The present society, it is hoped, will be able to demonstrate that the public schools are the proper places to commence the study of this important branch of education, which is of immediate value, not only in business pursuits, but also for the aid it is capable of constantly affording the pupils in the prosecution of their studies. As a Section of the Franklin Institute, it is believed its influence will be more sensibly felt and more enduring than that of the organizations which preceded it.

A student of the so-called "standard phonography," read without hesitation a note written in Pitman's phonography. Pitman's system preceded all others now in use, and is more widely practised than any other. As it has borrowed from none of the others, we may put the following query: Whose system is entitled to be called "standard?"

The Franklin Institute class in phonography will commence on Monday, October 8th, 1877.—*From advanced sheets of Franklin Institute Journal.*

ÆSTHETICS AND HYGIENE.

IN THE CONSTRUCTION, WARMING AND VENTILATING OF MODERN DWELLINGS.

Much has been written upon the subject of heating and ventilating generally, and much also upon fire-proof construction, of the need of which latter we have recently had such sad reminders. And while, perhaps, many examples of good practice in these arts may abound in public buildings, there is, undoubtedly, a sad want of any recognized system of economics in private dwelling construction, far too little attention being paid to important demands of the latter. It is probable that, until the average technical education of the dwellers in cities shall be raised considerably above its present level, that not much more attention can be expected to be paid to such matters by even those who own their domiciles, much less, of course, from landlords. That the time will come, however, when a better state of knowledge and practice upon such subjects shall prevail, cannot be doubted, for that necessity, which knows no law but its own imperiousness, will compel the change to be made. In the matter of heating, the increased cost of fuel to the inhabitants of the world, as this planet advances in age, will necessitate a more economical use of such fuel, or what is the same thing, a greater care in utilizing as many units as possible, of the heat actually generated by any given weight of combustible consumed. This attempt will in its turn (as is even now being practiced) largely exclude all access within inhabited structures of external air of low temperature, every cubic foot of which mingling with the warmed air of the apartment, or coming in contact with the heat-giving surface warm, ing it, beyond that absolutely required, becomes an agent for the deprivation of warmth which has been paid for in money, and from which no benefit can be derived. But this attempted regulation to a nicety, or to a known and controllable quantity, of the admission of warm air involves the further provision for a neither too rapid nor too slow circulation of said air, by also providing suitable means, in proper proportion, for the exit of the already warmed air, which has been rendered impure by inhalation and exhalation.

The economics of artificial heating and ventilating in cold climates, owing to the necessities of man's nature, becomes a problem in more pressing need of solution than that of artificial cooling and ventilating in a tropical climate, or in the midsummer temperatures of the temperate zones, yet the physicist knows that the feeblest draught, a breeze, a gale, nay, the gentle dew, the rain-torrent, the lightning's flash with its attendant thunder-roar, alike only require but a more or less disturbance of the equilibrium of aerial temperature to generate the one or the other; and yet to artificially cool and ventilate in hot weather upon any extended scale, no less than to warm and ventilate artificially in cold weather, requires an expenditure of power and the application of physical law, by the skillful manipulation of physical forces. The relative cost of the two processes will, however, depend upon many circumstances surrounding the two cases, and too much care can not be exercised by professional men in scrutinizing all plans relating to sanitary engineering (under which we class lighting, heating and ventilating, as well as draining), which are proposed in supposed conformity to physical vital law.

So far as the application of the principles herein laid down for practical operation in dwelling houses shall be applicable to audience halls or public buildings, the same may be considered as intended to apply thereto, but the main object of this article is to offer some practical suggestions for the economic heating and ventilating of dwelling-houses, combined with general features of construction, not so much with the view of presenting anything new or startling, but simply by reiteration to assist in gradually educating the popular mind to the importance and true beauty of the subject, for, but by the continuous teachings of the press can the public mind be enlightened in even very simple technical matters. Too many engrossing cares daily arise to prevent much research and thought upon such subjects among the otherwise well-informed great mass of a city's population, hence the great value of the daily, hourly, "lightning" and light-giving press as an ever-present popular mentor and educator.

With these general reflections we pass to the main object of this article, which will probably be sufficiently practical and, withal, popular without entering into numerical calculations or the expression of many numerical values. At the risk, therefore, of repeating what may have been better said heretofore, let us commence our modest structure at its foundation walls, and design its general features in conformity with good principles of heating and ventilating.

If the house can be built upon piers, with no general cellar, and with only—where it cannot be avoided—a cellar under a portion of the house for the location of the heating apparatus, so much the better. In or near the centre of the house should rise a hollow shaft of fire-proof material, in which should be located all smoke flues, one main hot-air distributing flue and any necessary ash-shafts, though the latter, when required, may be built for greater economy of space in the exterior walls of the house, where neither smoke flue nor hot-air flue should be located. Suitable connections can readily be made with either the central smoke or hot-air flues from the passages direct, and from the rooms, when such connections are required, through fire-proof flues run-

ning between the floor-joists. Such flues (for hot-air, of sheet-tin embedded in plaster of Paris, or some similar non-heat conducting material) can be built at a reasonable cost, and, withal, be perfectly trustworthy.

Now, assuming any one apartment capable of containing a certain number of persons, there must be allowed for each one of such number, each minute, a certain number of cubic feet of pure air at the desired temperature in excess of the volume absolutely required by the lungs of each individual, in order to insure the obtaining of that necessary volume by each person. From four to five cubic feet of air per minute is considered the least quantity that should be allowed for the average consumption of one person. That the volume determined upon to enter the apartment shall not cause the sensation of a draught or breeze to be felt, the velocity of the current of air admitted, in its passage through the apartment, it has been stated, as the result of careful experiment, may be allowed to vary from five to fifty feet per minute. With such data for his guidance, the calculation of the necessary entrance and exit conduits for the air becomes an easy task to the engineer.

The kitchen should be located immediately under the roof, and should have a suitable egress below, if possible, by means of a stairway separate from the main stairway of the house. The kitchen should also open at its floor-level if the area of the ground plan be sufficient, either immediately, or through an intermediate passage, upon a flat roof, or a roof covered by a flooring of slats. This roof should form the laundry suitable for use in all but the most inclement weather; here the clothes might also be dried, and at times it could be used as a resting place for obtaining out-door air—having a ligh roof covering, but open entirely upon at least one side. Thus, if a house so constructed had no enclosure or yard, but covered its entire lot, the absence of such yard would be but little felt, and if it had a yard its adornments would not be marred by the presence of clothes or clothes-lines, or by any reminders of the kitchen, or by other unseemly sights. All disagreeable odors would escape in mid-air, the whole house and neighborhood being the gainer thereby. The laws governing health, comfort and good taste would all thus be practically taught, enforced by habit and, therefore, more generally obeyed.

All water pipes for lavatory and drinking purposes, and all drain and soil pipes, should be led according to a carefully designed plan consuming the least length of pipe for the purposes desired, and the freezing of such pipes should be an impossibility, at least so long as there was a *modicum* of fire in the house. It would be a wretched economy to have any of these pipes of too small diameter. It would be no difficult task in a house constructed upon the plan herein advocated, to prevent the freezing of the pipes in the coldest weather. In all houses of any pretensions to style or magnitude, the service water pipes should be led from the street mains into some light and clean passage-way or apartment, from whence all branch pipes should be led, each pipe carefully numbered, marked or labeled, so as to indicate its use, or the apartment or floor which it served, and provided with a suitable stop-cock or valve. By leading all these pipes up through some part of the walls of the central flue-shaft, so that they can obtain sufficient warmth therefrom, all danger of freezing can be avoided.

With such a system of dwelling-house construction, as herein indicated, no trouble should be experienced in locating all baths and water-closets in well ventilated clean apartments, exposed for some hours of each day to the direct rays of bright sunlight, and the drain and soil pipes could readily be connected with ventilating-shafts or with the main chimney flue, in addition to any foul-air traps that might be fitted to them.

Where houses are built in rows or blocks, but little difficulty will be experienced in providing a central shaft or chimney, within party walls, containing the necessary flues for the use of two adjoining houses, and while for the single house, standing alone, some might begrudge the space occupied by a central shaft, yet the great economy of heat obtained by such construction and the many other advantages incidental to the use of an internal, rather than an external chimney already indicated, such as health, comfort, convenience and more sightly appearance are quite manifest. In the style of architecture so much favored at present, how many are the Mansard roofs constantly appearing to the eye, presenting numerous breaks of tall chimneys springing through their inclined sides? This marring and mingling of ornamental roof with ill-sorting chimneys is surely violative of all architectural beauty, and while a sense of partial utility may tolerate such construction, it certainly should be condemned in the light of truest utility, and be considered equally obnoxious to the beauty of harmony and unity of style.

May we not in architecture, and indeed, in all art, profitably ever bear in mind the maximum of the Latin poet in his epistle upon the art of poetry—"*denique sit quod ris, simplex, duntaxat et unum*," which, if we may be allowed a liberal translation, we will interpret thus—" finally, whatever you undertake, let it be of simple construction and withal, in complete concord with itself."

P. R. VOORHEES.

Philadelphia, Sept. 4, 1877.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

SECOND PART—IV.

Problem VIII.—A Stephenson link-motion, with open rods, is to be constructed, to cut off at $\frac{4}{5}$ of the stroke when at full grades, with a lead of $\frac{1}{8}''$. The largest port opening for the full grades is required to amount to $1\frac{3}{8}''$ and the inside lap to be $\frac{1}{8}''$. The link is of the form shown in Fig. 25, its length $P'P''$ is 12″, the distance of the pins P' and P'' from the centre-line of the slot is 3″ and the length of the eccentric rods is 3′ 6″. The link-block is directly geared to the valve-stem, and at full grades the eccentric rods are to be in line with the link-block. The proper dimensions and positions of the valve and eccentrics are required, and besides the elevation of the link when required to cut off at $\frac{3}{5}$ and $\frac{2}{5}$ of the stroke.

Since we know the greatest port opening, the lead, the point of cut off and the inside lap, for both full grades, we can find the the points Q' and Q'' of the valve diagram (Fig. 42). Next we

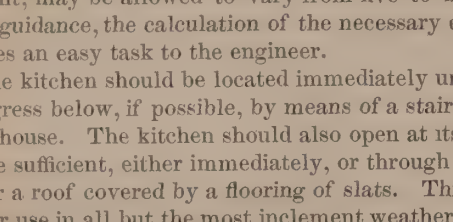

Fig. 42.

locate the link $P'I''$ (Fig. 43) in its neutral position in mid

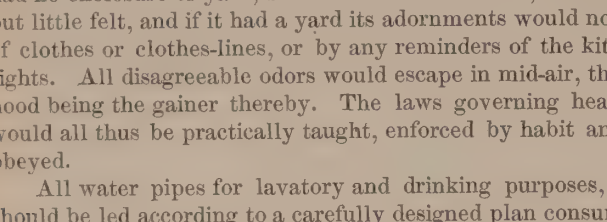

Fig. 43.

ear at reduced scale. Mark the eccentrics I' and I'' to correspond with Q' and Q'' of the valve diagram, draw the line $I'i°$ at right angles to $P'O$ and bisect $I'i°$ parallel to $P'O$ to get the centre o of the locus. The locus can now be drawn in Fig. 43 and transferred to Fig. 42. In Fig. 43 the point n can also be marked, either by extending the circle of the locus or by drawing $I'n$ parallel to OP'. To find the positions of the link for the required intermediate grades, we draw the crank-angles OE' and OE'' (Fig. 42) to correspond with $\frac{3}{5}$ and $\frac{2}{5}$ of the stroke of the piston, and find on the curve $Q'Q''$ the centres q' and q'' of the lap circles that are tangential to these crank angles. Finally we transfer the points q' and q'' to Fig. 43 (i' and i'') and draw the lines Ob' and Ob'' parallel to $i'n$ and $i''n$, and b' and b'' are the points of the link for the required intermediate forward grades; those for the corresponding backward grades are in a symmetrical position. We find, besides the angle of advance $=\delta$, the throw of the eccentrics $OI' = OI'' = 2\frac{3}{8}''$ the outside lap $= 1''$ The radius for the centre-line of the slot of the link should be $= 3'6'' + 3'' = 3'9''$.

Problem IX. A Stephenson link-motion with open rods is required with a link of the form shown in Fig. 26. The cutting off for the first forward grade is to take place at $\frac{4}{5}$ of the stroke, with a lead of $\frac{1}{4}''$. The largest port opening is to be $= 1\frac{3}{8}''$ and the inside lap $\frac{1}{8}''$. It is desired that the lead should be equalized for the forward grades. The length of the eccentric rod is 3′6″, the link-block is attached, at a leverage of 9″, to a rocker, from which the motion is transmitted to the valve by an arm of 12″ length. The centre line of the engine is inclined to the centre-line of the link-motion, by an angle of 15°, as shown in Fig. 44. The length of that portion of the link ($b'b''$ Fig. 40) that is actually used is to be equal to three times the

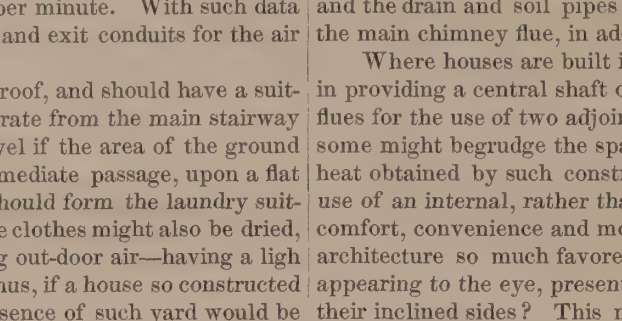

Fig. 44.

travel of the link-block when in full gear. It is required to construct the valve diagram, to find the throw and the position of the eccentrics, and the length of the link shall be determined,

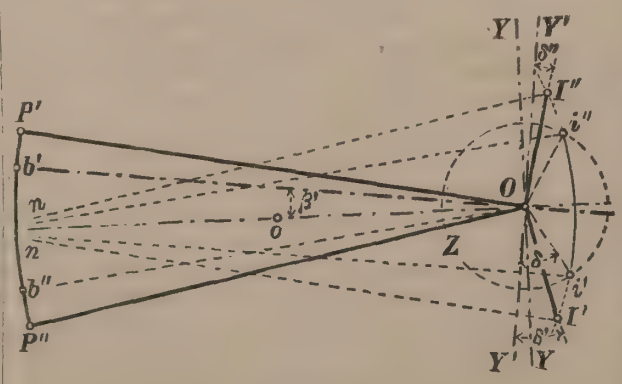

Fig. 45.

if the distance $P'b'$ (Fig. 40) is $= 3''$. Any question relating to intermediate grades can, of course, be solved as in the preceeding problem.

The required valve diagram is shown in Fig. 41. At first we can construct the centre Q' for the first forward grade, showing the travel of the valve at that grade to be $4\frac{1}{2}''$ with an outside lap of $\frac{7}{8}''$. Owing to the unequal leverage of the rocker, the corresponding travel of the link block is $3\frac{3}{8}''$ and the length $b'b''$ of the link is accordingly $10\frac{1}{8}''$. The length of the eccentric rods being given, we can now locate these two points of the link at reduced scale (Fig. 45) and find the angle β', which is the angle of equalization of the lead. We can thus consider the case in the way shown in Fig. 39, *i.e.*—we consider the line Ob' (Fig. 45) as the base line of the diagram of eccentrics, and can accordingly transfer the point Q' (Fig. 41) of the valve diagram to its proper position i'' in the diagram of eccentrics Fig. 45, by the angle δ. The locus can next be drawn, as usually, and it should be extended to both sides, in this case. The drawing of the link can then be completed by making $b'P' = b''P'' = 3''$, and the points I' and I'', corresponding to the points P' and P'' are found by making nI' and nI'' parallel to $P'O$ and $p''O$, respectively. But for the unequal leverage of the rocker the points I' and I'' would represent the eccentrics by which the points P' and P'' of the link should be worked, and their throw would be $3\frac{1}{4}''$. But as the case is, this figure is subject to a reduction and the actual throw of the eccentrics must be made $= 2\frac{7}{16}''$.

When we complete the valve diagram, Fig. 41, we find the lead for the first backward grade to be negative, about $\frac{1}{4}''$, which is certainly not a very desirable feature. The variation of the lead in the present link-motion assumes such proportions, on account of the rather unusual shortness of the eccentric rods.

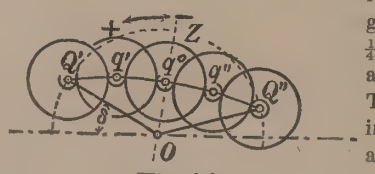

Fig 41.

The slot of the link should be curved by a radius of 3′6″ equal to the length of the eccentric rods.

To find the proper position of the eccentrics on the crank shaft we determine the angles δ' and δ'', the line OY' forming right angles with the base line $b'O$ (Fig. 45). Then we draw the crank OK (Fig. 46) on its centre, which is at an inclination of 15°, and locate the eccentrics I' and I'' by their angles of advance, δ' and δ''.

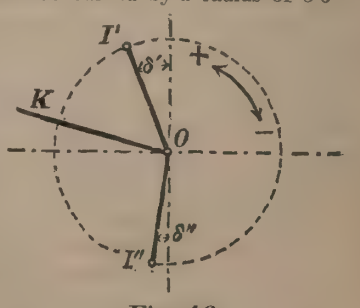

Fig. 46.

To be Continued.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Electricity in War.—The *Globe* newspaper of August 23 says: "There are few of those scientific and practical discoveries usually numbered amongst the "blessings of peace" that have not been turned to account to intensify the effects of war. Steam, that quadruples trade by diminishing distance and multiplying carrying power, also accelerates the speed of armies and augments the number and the force of destructive weapons, missiles, and engines. In like manner electricity, which annihilates space, not only gives wings to messages and counsels of peace, but brings into instantaneous communication the field of battle, the commander's tent, and the council-chamber where sovereign and ministers debate on policy, and condenses into weeks the consultations and the operations that, without this aid, would be the work of years. But this is only a small part of the duty which electricity seems destined to discharge in the wars of the future. It was thought only the other day that its most effective work would be in the firing of submerged and invisible torpedoes, as far removed from the actual touch of those who should use them as from the knowledge of those for whose destruction they were to be employed. But electricity is as Protean as life itself; and its beneficent form of to-day is constantly found to neutralize its noxious form of yesterday. The fitness of the electric light to circumvent the torpedo has engaged the experimental efforts of military scientists for some time past; and, judging from what is known of the practice made on Monday night in the Medway, those efforts have led to a very appreciable success. The electric light apparatus which has been fitted up on board the new war-ship Temeraire was brought into play, and the effect was such that we are told no hostile vessel could have approached the illuminated ship within two miles without being seen. The results of the general adoption of this light, supposing it can be continuously relied upon, must go far to destroy the mysterious terror which at present surrounds the torpedo. Had the Temeraire been in the midst of foes on Monday night, it would not have been possible for a torpedo-boat or ship to come near enough to discharge a moving torpedo without herself becoming a conspicuous mark for the Temeraire's guns. Add to this the use of the light in revealing stationary torpedoes planted under the sea, and we may safely congratulate ourselves upon our command over this manifestation of the electric force."

Artificial Coloring of Cigars.—According to a little brochure, published lately by M. Haase, cigar manufacturer in Bremen, the artificial coloring of cigars is daily becoming more common. Most of the smoking public prefer strong and dark-colored cigars to the light and bright-colored. M. Haase reports that 76 per cent of his purchasers order the former, and only 24 per cent. the latter. It is further known that most cigar-smokers prefer a cigar of a regular brownish color to an irregularly-colored, red, dun, or spotted cigar. On the other hand, the color of raw tobacco tends rather to bright than to dark, and the bad crops of the past year have furnished much bad-colored tobacco. Hence, with an increasing proportion of bright-colored and bad-colored tobacco, and the demand for the dark tobacco, the use of coloring sauces has increased. These sauces are all of pretty harmless ingredients, generally some dilute dyewood extract in ammoniacal solution; but, indeed, these extracts contain no natural tobacco color. M. Haase condemns the practice; any artificial alteration of a natural product, like tobacco, in order to give it a better look, is in itself improper. Then the natural color of the covering leaf is of essential influence on the strength of the cigar, and most smokers lay great value on the color. But, with artificial coloration, the judgment is deceived, and a right inference from the external color to the quality of the cigar rendered impossible. Rubbishy cigars can, by coloring, be passed off for good. Hence all artificial coloring of cigars with such sauces must be regarded as a falsification of the goods for deception of the public.—*Eng. Mech., xxv*, 631.

The Alteration undergone by Oak Wood. which has remained a long time in water is remarkable. This was observed at Rouen in 1830, in the case of pieces of oak from an old bridge built in 1150. M. Berthier reports in a chemical work that the wood was like ebony, and the modification was found due to the presence of peroxide of iron. Another case has just been recorded by M. Charrie-Marsaines. Having occasion, in constructing a discharge sluice on the Rhine, to demolish an old military dam, built by Vauban in 1681, and based on a platform which consisted of oak wood in a cubical block of 80 metres, he found this wood to have a dark color, quite like that of ebony, and very great hardness, as was found on trying to cut it for re-employment in the new works. The wood then had been 146 years in a soil constantly soaked with water, in virtue of the permeability of the gravel layer which here forms the bed of the Rhine.—*Eng. Mech. xxv*, 631.

Glass Works at the Permanent Exhibition.—The *Exhibition Journal* contains the following: That the Centennial Glass Works, with all the curious methods of production, should be erected inside of the Permanent Exhibition building, gives us, perhaps, the most correct idea of the vast extent of this great edifice. In the wide range of modern industries the workshop in which the glassmakers toil is the most picturesque. The space devoted to manufacture contains a tall, tower-like melting furnace, tapering in form, widest at the bottom and narrowest at the top. It is provided with several fire-clay melting-pots, under which rages a fierce fire of bituminous coal. Around and about this red-hot furnace is continually flitting a large force of men and boys. Half a dozen of the latter, armed with iron rods, go briskly to the towers, bringing out balls of metal on the ends of their sticks, roll the crimson globes on tables of iron, swing them to and fro in the air, plunge them into the mouths of smaller fountains of flame, called the "glory holes," and roll and turn and twist the incandescent balls at the ends of their whirl-rods.

From this process the glass passes to the moulding stands, where it is reduced to form and shape, filling the spectators with wonder at the sight of goblets, pitchers, vases, dishes, etc., rapidly developed from the red-hot metal. Next it is plunged into pools of water appropriately arranged. Blown and molded, the glass is next annealed, being conveyed by the active boys to the ovens, where it passes from an intense degree of heat through graduated temperatures until perfectly cool. The less expensive grades of glassware are now ready for the market, but frosting, cutting, und engraving have still to be added to superior qualities. The frosting process is accomplished by causing the brittle metal to revolve rapidly in close contiguity with little stones and pebbles; cutting and engraving, by means of a wheel and pan, which must be operated with the nicest skill.

Japanese Mirrors.—Repairing of mirrors is a process to which the art of Europeans and Americans has not yet arrived. As they make mirrors in Japan, however, the process of repairing is no more difficult than that of mending a stove. The Japanese mirror would seem to be only an improvement on that used by Helen of Troy—a metallic affair burnished and polished. It is a bronze disk, composed of eighty parts of copper, fifteen of tin, and five of lead. It is cast in a mould composed of powdered stone and pulverized crucibles. The casing is polished by hand, as the Japanese alone can polish, and the last process is to rub the surface of a mirror with an amalgam composed of quicksilver, tin, and lead. And this is done by hand and with a piece of wash leather, till the mirror has a bright reflecting surface. This surface solves the problem of repairing *some* mirrors, since it can at any time be readily repolished.

At every stage of the work the choicest materials are employed. The cheapest mirrors have sulphide of lead and antimony instead of tin in their composition.

A curious optical effect can be produced by some of these mirrors—probably the best finished. On the reverse, which is also polished, are words and figures in relief. By throwing in a bright sunlight the reflection of the mirror on a screen, these figures are seen to shine through the reflected surface of the mirror. The fact is noted by an English professor in the University of Tokio, R. W. Atkinson. He has been able to discover no satisfactory solution of the phenomenon, but it is certainly one worth investigation. The body of the mirror is absolutely opaque, and there must be some law of refraction, yet not fully discovered, to account for an appearance so singular. —*Philadelphia Ledger.*

Adulteration of Fuchsin.—*Le Teinturier practique* contains an elaborate article on the adulteration of Fuchsin, from which we glean the following:

The adulteration of Fuchsin by means of bronze filings is so well known and so easily recognizable that it scarce deserves mention here. The mere immersion of the aniline dye in a solvent leaves the filings undissolved. Fuchsin has, however, been of late brought into the market, which contains 15, 24, and often even 82 per cent. of raw or unrefined sugar. Fuchsin adulterated with 15 per cent. sugar is sold at the same price as the pure article, while that containing 82 per cent. is somewhat cheaper. If such adulterated sugar be spread upon a sheet of white paper and examined with a microscope the arborescent crystals of Fuchsin with their reddish appearance on the edges are at once apparent; while the sugar appears in granular crystals which have a garnet or amethyst color. If the adulterated dye be heated on the point of a knife, the smell of burnt sugar is at once noticeable. —*Papir Ztg.*, ii, 570.

New Reaction for Morphia.—The solution of the suspected matter is evaporated at a gentle heat; the residue is treated with concentrated hydrochloric acid to which a small quantity of pure concentrated sulphuric acid has been added; and the mixture is evaporated in the oil-bath at from 100° to 120°. Whilst the hydrochloric acid disappears, a most beautiful purple color begins to form on the edges of the capsule, which is not masked by the carbonization of the organic matter; then a red color extends down toward the centre of the capsule, and when all the hydrochloric acid has disappeared the remaining sulphuric acid appears of a red color. At this moment the capsule is carefully taken out of the bath, a little hydrochloric acid is added, and the whole is neutralized with bicarbonate of soda. A violet color is then produced, which does not alter in the air nor dissolve in ether. If a drop of ioduretted hydriodic acid is now added the violet color changes to a green, which dissolves in ether with a purple color. Codeia gives the same reactions, but as morphia is insoluble in ether, the two may be easily distinguished. Brucin treated in the same way, on neutralization with bicarbonate of soda, gives a beautiful azure, which turns red with iodine.—*G. Pellagri.*

The Preservation of Wine by Means of Salicylic Acid.—Prof. Nessler, of Carlsruhe has discovered a means by which wine can be preserved by meahs of salicylic without necessitating a mixture with the same. He recommends the use of molten paraffine, containing 2 per cent. of salicylic acid for the saturation of small sticks of wood or cork, say of 15 m. m. length and 2 m. m. thickness, which are to be thrown on the surface of the wine, and thereby prevent the formation of mold. Experiments showed that wine, which would ordinarily spoil on an exposure of 8 days to the atmosphere, was with the addition of the wood particles so prepared, perfectly clear and sweet, even after an exposure of 4 weeks. If mould has already been formed the addition of alcohol effectually kills the same, and causes it to fall to the bottom of the vessel. The addition of the salicylic acid in the way described prevents further formation. The cost of thus preserving wine would not exceed 15 to 20 cts. per barrel.—*D All. Polytech. Ztg.* v, 406.

An Invention Wanted.—The General Council of Guadaloupe offers a prize of $20,000 to the inventor of a new process of extraction of juice of sugar cane, or of sugar fabrication. This prize will be given to whoever obtains from the cane a yield of 14 per cent. of sugar. The cost of application of the new process should not exceed 40 per cent. of the value realized. Experiments will continue four years, terminating June 30, 1880, and will take place at Guadaloupe under the auspices of a government commission. All cost of transport, etc., must be defrayed by competitors, and applications, etc., must be addressed to the Director of the Interior, Basse Terre, Guadaloupe.

The cane raised at Guadaloupe contains 18 per cent. of sugar. Hitherto a percentage of 9.4 on an average has been obtained by the ordinary factory machinery. Recently M. Ducharsaing has invented an imbibition process,, the details of which are not given in the legislative documents, but which, it appears, increased the yield from 9.4 per cent. to 11.64 per cent. The inventor himself claims a greater advantage, and insists that the additional percentage of gain by his process is 2.33 per cent. instead of 1.64 per cent. Even on the lower estimate M. Ducharsaing's invention was deemed sufficiently important to warrant the awarding to him of a $20,000 prize. The present premium is, therefore, a second one, and the winner is called upon to make a still further improvement. The experiments must be conducted on at least 660,000 pounds of cane.—*Western Manufacturer, iv*, 516.

New Calculations of the Sun's Distance.—A somewhat unexpected result is obtained by the reductions of the British observations on the last transit of Venus. The data used are the eye observations (telescopic) in Egypt, Honolulu, New-Zealand, Rodriguez and Kerguelen. The photographic observations have not yet been reduced, and there are also eye observations taken in India and Australia that may be utilized, but it is not believed that any great change in the computation will be effected by the figures obtained from the latter source, and the value of photographic observations is as yet an open problem. The new British calculations give for the value of the sun's parallax, 8″.760, with a probable error of 0″.013. This correspondents to a distance for the sun of 93,300,000 miles, with a probable error of 140,000 miles. The curious feature about this is that it is, in some measure a return toward the old figures which made the sun's distance very much greater. These old figures from the transit of 1769 were believed to be in

error to the extent of three or four per cent. But if the new figures for the parallax be conceded, it will be estimated about midway between the extreme views. The following table will make this plain: in it, No. 1 is Prof. Encke's estimate from the transit of 1769; No. 2, Prof. Newcomb's as used in the American Nautical Almanac; No. 3, the estimate of Leverrier adopted by Prof. Hind and given in the British Nautical Almanac; No. 4, the recent deductions from the British observations on the last transit:

Estimate.	Parallax, seconds.	Distance, miles.
No. 1	8.5776	95,292,000
No. 2	8.848	92,381,000
No. 3	8.95	91,329,000
No. 4	8.76	93,309,000

N. Y. Tribune.

ENGINEERING—CIVIL AND MECHANICAL, &c.

The New York Suspension Bridge.—The progress already made in the superstructure of this great work, is considerable. Three strands of each of the four cables are now stretched across the river. A large part of this work has been done during the last week. There will be 19 strands in each cable, however, each strand being composed of 286 cast steel wires. The wires in the strands are now bound together with steel bands two feet four inches apart. The present bindings will be removed, however, when all the strands are in position, and workmen in buggies, as they are called, will bind the entire cable together with the assistance of a wrapping machine. Not one entire cable, however, will be finished this year. It takes about eight days to lay the wires of one set of strands. The wire used for the cables is galvanized cast steel wire, manufactured expressly for the bridge company. It is made perfectly straight, and there are no kinks in it when it is unrolled. Every piece is severely tested at both ends before it is accepted. In the enclosure where the New York anchorage stands two excavations for the first archway foundations are also in progress. Mr. Collingwood, the engineer in charge on this side of the river, does not think that the construction of the foundation will begin until October, as the stone has not yet been obtained. No houses have been demolished in New York by the bridge-makers since the space where the anchorage stands was cleared, two years ago, except on the corner of Dover and Cherry streets, which was torn down last spring. Fourteen buildings, however, will be razed during the next month, five of them being large brick stores which face Pearl street, on the corner of Frankfort. The other buildings are along the line of Frankfort street. The houses on the two blocks bounded by South and Water streets, and Dover and Roosevelt streets, have been cut down and furnished with fireproof roofs. In digging for the foundations of the archways on this side of the river, pumps have been called into use; but more or less water is always encountered in digging to any great depth along the river line in New York below the high water mark. The diggers have found no steadily flowing streams, but the water percolates through the sand from all sides.

The anchorage pier in New York rises like a monument in the midst of one of the worst neighborhoods of the metropolis. The western terminus of the bridge roadway will be in Printing House Square, the centre line, according to the engineers plans, ending exactly 18 inches north of the north-west corner of the *News* building. A narrow street will run at the base of the arches along the entire northern line of the roadway.—*The Chicago Railway Review*, xv, 83.

Iron Ship Building.—The *Pall Mall Gazette* prints some information touching the progress of iron ship building in the United States. Five years ago England had a decided advantage over North America with respect to the cost of ship building, the materials and the labor being much cheaper. But a great change has taken place in the meanwhile, for the price of American iron has fallen nearly 50 per cent., and the present rate is not much above that of the principal European markets, while copper is now produced in such quantities that it has become an article of exportation. The price of labor, which is the most important item in the construction of vessels, being estimated at 70 per cent. of the total cost of a steamer, has also been reduced by the use of machines, which are not employed in England. The first iron vessel constructed in the United States was built in 1868, and since then 251 ships of various dimensions, with a tonnage of 197,500 tons, and valued at from £12,000,000 to £15,000,000, have been launched, this being an average of 30 every year. These figures are very insignificant when placed besides those concerning the ship building on the Clyde, but the United States' returns for the last four years show some very remarkable results. Thus the tonnage of vessels constructed was 224,000 tons in 1872, 266,000 tons in 1874, 270.000 tons in 1875, and 204,000 tons in 1876. Upon the other hand, there has been a rapid decrease in the number of screw-steamers built on the Clyde since 1873—from 126 in that year to 113 in 1875, and to 83 last year. There has not been any decrease in the number of paddle-wheel steamers, of which 16 were built last year, against 14 in 1872 and 10 in 1874; but in the United States, the yard of Mr. Roach—one of the largest ship building in the country—has turned out 36 paddle-wheel steamers with a total tonnage of 68,150 tons.—*American Manufacturer*, *xv*, 14.

A Steel Wire Suspension Bridge in California.—The Pacific Bridge Company are building in Mendocina county, California, at Cottoneva, a suspension bridge which is described as follows: The distance from centre to centre of the saddles on the towers is 270 feet. The deflection or fall of the cable is 23 feet 6 inches. The cables are built in the same manner as those of the Clifton bridge, at Niagara. The steel wire is about No. 11 Birmingham gauge, and is protected against rust by immersing in a bath which gives it a fine coat of zinc. There are eleven wires in each strand, seven strands in each 1½ inch rope, and seven ropes in each cable. The ropes are not twisted together to form the cable, but gathered up every 6 feet by the suspender bands. Each rope is warranted to bear a strain of 60 tons. It is made fast to an independent anchor bar, 1 by 3 inches in diameter, and forming links 18 feet long, until connection is made with the anchors. The anchors are of cast iron, 3½ by 3 feet in surface, weigh 1,000 pounds each, and are placed 14 feet below the surface of the rock. Great care was taken in securing these anchors in place by means of cross I beams which run under the rock on either side. The lower part of each pit was enlarged so as to form a hemispherical chamber, and the rock work, set in Portland cement, which is built upon the anchor, is so constructed that the upward strain is transmitted to its sides. The towers are of red wood. There are four posts 10 by 10 inches, and two 10 by 12 inches, giving an effective area of 640 square inches to withstand the strain of the cable on the tower. The wooden truss to prevent vertical vibration is 8 feet high and of the Howe truss pattern. The 270 feet of the bridge is divided into 45 panels. The longest suspenders, 44 in number, are of ⅞-inch steel wire, the 42 shorter ones are of 1⅛-inch solid iron. The estimated dead load of the bridge is 1,000 pounds per linear foot; live load, one ton per linear foot; in all, one and one-half tons, or one-fifth of the actual breaking load. The bridge will be completed in a few weeks.—*American Manufacturer*, xv, 5.

Asiatic Railroads.—According to the journal of the Imperial Society of Geography of Vienna, M. Hochstan, president of the Society, has recently published a pamphlet on the different projects studied for the establishment of a railroad through Central Asia and China. The following are the four principal routes:

1. The Baranowski project. Saratoff is the proposed point of departure. From here through the country of the Kirghises and over the Hindoo-Koosh Mountains. This is the road of greatest travel to Moscou and Peshawur; the principal fortresses of the valley of the Indus.

2. The Lessep-Cotard project. From Orenbourg to Peshawur by Oursk, Taschkend, Samarkand and Balk.

3. The Bogdanowitch project; the principal points of stoppage being Moscou, Kanzan, Ekatherinobourg, Oursk, Tomsk, Irkutsk, and Pekin.

4. The Ruhthhofen project. This would be along the Siberian route to Oursk, passing Tachkend, Samarkand, and Balk. At this point the road leads towards the West, and passes Teheran and rejoins at Tiflis the Russian roads of the Caucasus now in process of construction.—*Revue Industrielle*, viii, 358.

An Electrical Apparatus for noting over-strain or weakness in bridges or other structures, has been patented by Mr. John Forbes, of Nova Scotia, which is thus described: The invention consists in attaching upon each member of the structure an insulated wire or conductor, so arranged that an electric circuit may be made or broken, by any mechanical means, by the abnormal condition resulting from the excessive strain or dislocation of parts, from whatever cause it may arise, through which a motion either in the substance of the member itself or between contiguous and adjoining members has taken place, the closing or rupture of the circuit to be indicated by an annunciator, operated by the electric current from a battery through electro-magnets suitably arranged, the armature of the magnets being so adjusted that, as in the case of hotel call-bells, a number or indicator shall be exposed, said number to indicate a particular part or member of the structure.

Progress of the St. Gothard Tunnel.—During the week before last the work of the St. Gothard tunnel progressed 15.2 m. at the Goeschenen and 28.1 m. athe Airolo end, a progress of 6.2 m. per day.

Three and a half days' work was lost at the Goeschenen end in verifying the direction of the tunnel—*Moniteur Ind. Belge*, iv, 387.

MINING, METALLURGY AND MINERALOGY.

A Number of Mica Deposits have been found in Massachusetts. We do not know in what portion of the State, but the Boston *Bulletin*, in speaking of them, mentions such places as Blanford, Russell, Chester, Lucas, Huntington village and Williamsburg. At least one mine has been opened—the Blandford—by a company who have a capital of $50,000, and who talk of building a crushing mill. Parties have also commenced working the bed which has been found in Russell.

The International Geological Congress.—The following is an abstract of the report presented to the American Association for the Advancement of Science, by Prof. T. Sterry Hunt, Secretary of the Committee for an International Geological Exhibition and Congress, to be held at Paris in 1878. The Committee consisted of Messrs. W. B. Rogers, Jas. Hall, J. W. Dawson, J. S. Newberry, T. Sterry Hunt, R. Pumpelly and C. H. Hitchcock; together with T. H. Huxley, for England; O. Torell, for Sweden, and E. H. von Baumhauer, for Holland. At a meeting of the Committee at Buffalo, on the 25th of August, 1876, James Hall was chosen Chairman, and T. Sterry Hunt, Secretary. It was then agreed to prepare a circular setting forth the plan of an International Geological Exhibition, which should form a part of the general exhibition to be held at Paris in 1878, and indicating a scheme for the organizations of the geological collections to be sent by all the nations taking part in that exhibition, and moreover proposing an International Geological Congress, to be held at Paris, as set forth in a circular. The circular was duly prepared and printed in English, French and German, and before the end of the year had been sent by the Secretary to the principal scientific societies and academies, as well as to the workers in geology throughout the world. The response to this invitation has been most gratifying. The Geological Society of France has formally recognized the great importance of the objects proposed, and promised its hearty co-operation; while private letters from its President to the Secretary of the Committee, and from Prof. Hebert to Prof. James Hall, give cordial assurances of the same kind. Spanish and Italian geologists have translated and published the circular in their respective languages, and have communicated to the Secretary their strong approval of the plan. Prof. Capellini has published an interesting correspondence, calling attention to the fact that he, in 1874, laid the project of a similar International Geological Congress, to be held in Italy, before the Italian Minister of Agriculture, Industry and Commerce. The Geological Society of London, and the Geological Survey of Great Britain, have also formally signified their approval of our objects, and the co-operation of Norway, Sweden, Russia and Austria-Hungary is promised. It is to be regretted that Germany has declined to take a part in the International Exhibition of 1878, but we trust that this will not prevent her geologists from joining in the proposed Congress. The director of the Geological Survey of Japan promises to take a part in our work, and we have the same assurance from Brazil, where the circular has been translated into Portuguese. Chili and Mexico have also responded, and promise an ample representation of their geology at Paris next year; while Canada, both through her Geological Survey, and in the person of Dr. Dawson, will probably be represented. The Government of the United States has as yet, failed to accept the invitation of France to take part in the Exhibition of 1878, so that American geologists are not certain that they will be able to participate in the International Geological Exhibition. In any event, it is probable that several members of our committee will be present at the proposed Geological Congress. It is recommended by the Standing Committee of the Association, that in addition to the names of Prof. J. P. Lesley, of Philadelphia, and Prof. A. C. Ramsey, Director of the Geological Survey of Great Britain, already added to the International Committee, the Presidents for the time-being of the Geological Societies of France, of London, Edinburgh, Dublin, Berlin, Belgium, Italy, Spain and Portugal, and of the Imperial Geological Institute of Vienna, be invited to form part of the Committee.

MISCELLANEOUS.

Central American Trade.—An American, long a resident of Nicaragua, and familiar with the resources of Central America and the habits and customs of the people, has lately contributed a series of interesting letters, setting forth the benefits that would accrue to the United States by making a ship canal across Nicaragua. He claims that such a thoroughfare would make New York the central commercial city of the world, and make San Francisco her associate. Besides this, he says, it would give American planters, mechanics and merchants an immediate and near field to create another India in place of that which is rapidly forestalling even our domestic products. Last year India sent nearly 3,390,000 cwt. of wheat to England—one-sixth as much as the United States, and one-third as much as Russia. The British revenue from India is $250,000,000 a year, or nearly the total cost of operating the United States government. The army in India employs and subsists 200,000 of Her Majesty's subjects and controls 240,000,000 of human beings. They make a commerce of $500,000,000 a year—cotton, jute, rice, tea and indigo leading. They give employment to 19,000 vessels and to 6,500 miles of Indian railroad, in which $500,000,000 finds a profitable investment. In Spanish America, which repeats nearly every natural production in India, and adds many others exclusively its own, there are less than 30,000,000 people, more than two-thirds of whom live on the Pacific slope; they are weary of revolutions, ripe for orderly government, hospitable to strangers, and frugal. With the help of organizing power and machinery, the writer thinks that this region might be made vastly productive and remunerative.—*Iron Age*, *xx*, 7.

Sewage, Drainage and Disease.—A special session of the Philadelphia County Medical Society was held, on Wednesday, September 19th, at the hall of the College of Physicsans, and matters bearing upon the health of the city was discussed. Dr. Richard A. Cleeman, in a report from the Standing Committee on Hygiene, introduced the subject of drainage and sewerage of the city as related to the prevalence of typhoid fever. Last year there were two hundred deaths in New York from that disease, and here there were 774 deaths, although the population of the former city is twenty-five per cent. greater than than of Philadelphia. This contrast leads to particular inquiry here from a standpoint of local interest. An enumeration of the agents by which the specific poison that brings about the fever is supposed to be produced, led to a review of the system of drains. Dr. Cleeman believed that the system now in use here does almost nothing to prevent the spread of typhoid fever, but that on the other hand it does little toward its direct development. It is desirable, however, that the sewers be so constructed as to carry off all organic refuse, which they now fail to do.

Dr. Benjamin Lee spoke upon the garbage nuisance. Typhoid fever, he assured the Society, is inducing mortality at a steady rate of increase. It is no epidemic wave, but some inherent fault that causes the zymotic disease to take such impetus to itself. The garbage man is a great helper on of the fever. Follow his loaded, or even his empty cart around and your nose convinces you that the the atmosphere is being vitiated. Servants leave the garbage barrels uncleaned and stinking. The odorless excavater was an improvement on the old way of cleaning cesspools, and sets a good example in the matter of garbage, which must be disinfected and deodorized as it is placed in a receptacle for removal. It is to be hoped that before many years the health authorities may devise some such improved means of removing the decomposing and rotten garbage. As swill-milk is poisonous, so the meat from cattle or hogs fed with this stuff is productive of disease also. He did not agree with Dr. Cleeman in the belief that the drinking water of Philadelphia is entirely innocuous, and thought that all drainage above the Schuylkill dams should be made through intercepting mains, or else typhoid fever will increase as heretofore. In a general discussion that followed it was mentioned that drinking water is delivered to the residents of the Twenty-ninth ward from the Belmont works, which take their supply directly from the river without going into the reservoir. Dr. Burns, of that locality, pronounced the water to be the most foul-smelling of any used for drinking in the world, and concluded that if typhoid is sorely caused by such impurity the Twenty-ninth ought to have three thousand deaths from that disease yearly. Dr. Cleeman said that an examination of the vital statistics of the city at the Health Office showed that there were four times as many deaths in that ward from typhoid fever as in any other ward in the city. Prof. Pepper, of the University of Pennsylvania, called attention to the fact that the large increase last year in the death rate on account of typhoid was due to the many unacclimated persons in the city. Dr. Parish threw out the point that large factories are frequently instrumental in choking up sewers with their refuse that should be carted away, instancing marble yards and their refuse sand. Drs. Nebinger, Hamilton and others also took part in the debate. The members of the Society who spoke all expressed their conviction that decomposing sewage and deficient drainage are prolific sources of disease, and that the great mortality from typhoid fever which still prevails is largely due to this cause. The drinking water supply should be carefully watched in order to prevent the introduction of any decomposing organic matter in which the typhoid fever poison is generally found.—*Philadelphia Times.*

Russian Telegraphy.—From a recently-published report on the telegraphs in Russia, in 1875, we learn that at the 1st of January, 1876, Russia possessed in State telegraphs, 61,287 wersts of lines and 118,299½ wersts of wire (the werst equals about three-quarters of a mile). The number of stations was 767. There were in use 1,777 Morse apparatuses, 100 Hughes, and 55,652 elements. The entire *personnèl* numbered 6,791 individuals, having increased 6·2 per cent. during the year. We note, *inter alia*, that of the foreign telegrams there were some 13,000 more sent to France in 1875 than in the previous year, and some 4,000 fewer to this country; also 3,490 fewer to Germany. Of the transit traffic through Russia, comprising 59,000 telegrams, 83·2 per cent. falls to Great Britain, 5·2 to Germany, 3·6 to America, 3·0 to France, 2·2 to Switzerland, and 2·8 to other States. (For further details see *Russische Revue*, VI. Jahrgang, 7 Heft.)—*Eng. Mech.*, *xxv*, 631.

In Watchmaking a new method of securing adjustment is announced. All the works of the watch except the main-spring are placed upon a circular frame supported at the centre, and by means of a geared rim round the inside of the case, this frame is turned entirely round once in two hours. This arrangement gives the works a circular motion round a common centre independent of their own proper movement, and secures a balance of all the parts by constantly changing their relative positions.—*Western Manufacturer*, *iv*, 518.

Rich Gold Mine in New Zealand.—The mail delivered during the week brings intelligence of one of the greatest discoveries yet made in the province. The discovery is at the Moanatairi mine, in the Thames gold field, not a great distance from the celebrated "Caledonia" mine, which in two years returned half a million sterling from a depth of 50 fms. The Moanatairi mine was productive to a depth of about 200 feet, when the lode became very poor. The company, nevertheless, decided to carry on operations, although at a great loss; and, after working over two years, struck the lode again nearly 100 feet deeper, when it was found to be from 8 feet to 10 feet wide, and almost solid gold. The returns since have been enormous—for the fortnight ending March, 3,709 ounces; ending 17, 4,913; March 31, 16,662 ounces. Making a total of 22,284 ounces, of the value of 70,000*l*. The yield for the last week of the above return was 10,298 ounces, and the profit for the fortnight reached the amazing sum of 43,000*l*. The fortunate shareholders have received in little over a fortnight over 60,000*l*., being 40*l*. 10*s*. per share. The last report says: "The present aspect of the mine warrants the prediction that the returns from the present level will continue splendid, to say nothing of the block underfoot, which, according to all precedent, should not only equal but exceed the block now worked. The height of the present block is 80 feet by any number of feet in a south-westerly direction. This is another instance of the success attending persevering efforts in mining, and should act as an encouragement to shareholders in other concerns, and warn them against the folly of letting their property be sacrificed when a sustained and united effort would, in the majority of instances, effect a great success.—*London Mining Journal.*

Glass Manufacture in the United States.—There are some 72 establishments in the United States devoted to the production of window glass and glass articles of general use and ornament. Twenty-seven of these are in New Jersey; the others are scattered through New England, New York, Pennsylvania, Maryland, Ohio and elsewhere in the West. The South and West Jersey glass works, however, are popular for producing a larger variety of wares than the establishments elsewhere.

In consequence, too, of the materials used in the manufacture of glass being found right at home, the factors have an opportunity of producing superior manufactures. To make a large market the prices that have ruled for some time past have been materially cut down this season, and still greater reductions may possibly be made, as the trade season makes its advent.

The capital invested in the glass industry is about $6,000,000 in New Jersey alone, while the annual production of the States is between 2,000,000 and 3,000,000 boxes of the various qualities and sizes of window glass. The number of cases of household, druggists' and chemists' goods, and other useful and ornamental wares, is carefully estimated at between 56,000 and 60,000. Several establishments produced thousands of dozens of patented fruit jars, and to these the present season is their busiest.—*Com. Bull.*

Mats and Rugs for carriages, doors, etc., are now made of felt by the following process: A piece of felt of suitable thickness is cut into strips three to five-eighths of an inch in width, and as long as the mat is to be wide. These are laid side by side on edge, and holes are made through them, and through these holes cords or fine wires are passed, and the strips are then drawn tightly together and fastened in place at each end of the wires. This gives a fabric as thick as the strips are wide, and of a light, flexible and elastic character. The strips may be in various colors, and may be disposed in any desirable pattern. These mats are reported to be strong and durable, and able to resist heat, cold, dust and severe usage. The color keeps well, because in dyeing the felt, before the strips are cut, a uniform color may be obtained, and when finished the mats have a good face on either side.—*Western Manufacturer*, *iv*. 518.

An American Substitute for Gum-Arabic.—It is said that the mesquite gum of Western Texas is almost identical with gum-arabic, and, during the past year, has become an article of export, some twelve thousand pounds having been gathered in Bexar county, and as much more between that and the coast. This gum exudes from the stem and branches of the mesquite, a mimosa, several pieces of which grow in Texas, New Mexico and Arizona.—*Journal of Microscopy.*

Sir Joseph Hooker says that a person may travel from England to Spain "without finding so diverse vegetations as by crossing the Mississippi and comparing the banks 100 miles east on one side with those 100 miles west on the other." In regard to California, there is no section of the earth where so many singular phenomena can be observed.

To prevent fires from the upsetting of stoves in railway accidents, a new device is offered, which surrounds the stove with a wrought-iron cylinder constructed in two halves. These halves are intended to close together firmly when the car is upset; at the same time a heavy damper is fixed in the aperture of the stove-pipe.

The Glue Pot has been improved upon in order to keep the article at the right temperature, avoiding the boiling over or becoming chilled. The heating process is applied at the base, which may be partially or wholly detached, as occasion may require, from the glue pot.

—Paper wheels are now being tested under one of the heaviest locomotives running over the Philadelphia, Wilmington and Baltimore railroad.

—Metallic sleepers are now expected to make rapid progress in Belgium; the employment of them had been long since decided on, and everything seems to indicate that the State engineers have now recognized the indispensable necessity of them.—*American Manufacturer*, *xv*, 13.

—The railroad bridge over the Alleghany river at Scrubgrass, was completed on the 10th inst. It cost $19,000.

An English paper says the British Patent Office Museum has purchased, at a cost of £28 15*s*., the Rev. Patrick Bell's Reaping Machine. It appears this machine was never patented, but that it has been purchased as an important link in the history of invention as applied to reaping machines.—*Western Manufacturer*, *iv*, 516.

—The Pratt & Whitney Company, of Hartford, report that the orders received during the present year had, up to the first of July, been more than twenty per cent. greater than during a similar time last year, and since then have more than doubled that proportion.

—The Pittsburg Industrial Exposition is now opened to the public. It is a very good display, and is being well patronized.

—The Baldwin Locomotive Works, at Philadelphia, are building ten engines for the Missouri, Kansas and Texas Railroad, four for the Atlanta and Charlotte Air Line, and two for the Greenville and Columbia.

—Messrs. D. W. C.Carroll & Co., Pittsburg, have the contract for the Round House for the Pennsylvania Railroad Co., to take the place of the one destroyed in July. The roof is to be of iron, supported with iron truss.

—L. B. Flanders, Philadelphia, lately shipped a "Patent Portable Locomotive Cylinder Boring Machine" to South America.

—The Follansbee Pump Company, 25 Kingston street, Boston, are running their works to full capacity.

—The Tremont Nail Company, Wareham, Mass., have put in a Siemens gas furnace, which has just been put in operation.

—The Boston *Commercial Bulletin* says the Wason Manufacturing Company recently sent fifty car-wheels to the Grand Trunk Railroad as a sample of their work, and shortly an order came back for 1,500 of the same sort.

—A narrow gauge road is proposed from Chattanooga, Tenn., to Rising Fawn, Ga., that will open up considerable quantities of bituminous coal.

—Dr. Leidy observed that multitudes of greenish monads are found on the beach. The size of a monad ranges from $\frac{1}{4000}$ to $\frac{1}{2400}$ of an inch in length; but what they lack in size they make up for in numbers, large patches of the beach being covered with them.

—Messrs. Pusey, Jones & Co., shipbuilders, of Wilmington, Del., have a contract with the government of the United States of Columbia, for the construction of two iron steam tugs, each 75 feet in length.

—Minneapolis, Minn., has twenty-one flouring mills, which turn out annually 1,300,000 barrels of flour and 13,000,000 pounds of feed, and consume 6,500,000 bushels of wheat. There are also twenty saw mills, which produce annually 200,000,000, feet of lumber, besides 160,000,000 shingles and 36,000,000 lath.

—The Shawmut Manufacturing Company is a corporation recently organized by Boston parties, with a capital of $250,000, for the manufacture of leatherette, a new English invention, the patent of which they have bought of the English patentee. The material is used extensively in book-making, etc., being an imitation of morocco board. Messrs. Rice, Kendall & Co., of Boston, have taken the entire contract to manufacture, and will occupy the building of the Turner's Falls Company at Turner's Falls.

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—Two vessels, Swatara and Monongahela, passed under the wires of the new bridge now building at New York, the mast of one reached 252 feet above the water. The wires are ten feet above the position of the floor.....Another compliment to America. Prof. Hilyard, of the U. S. Coast Survey, has been offered the position of director of the new International Bureau of Weights and Measures in Paris.....A new quarterly—*The American Journal of Pure and Applied Mathematics*, will be begun next January. William E. Story, Ph. D., is

the associate editor in charge.....The Boston Board of Health has been examining samples of candy with these results: Seven being yellow and green candies, contained the extremely poisonous chromate of lead or chrome yellow; one, white peppermint, contained plates of Paris, and eleven quite pure, or at least contained nothing poisonous.

—The largest orders received by Pittsburg glass factories are for beer bottles.....All the furnaces of the Allentown Iron Works are to be put in blast.....Hussy, Binns & Co., of Pittsburg, have just sent a sample order of 100 dozen shovels to Germany.....The Lancaster Watch Company has been formally organized, and H. S. Gam elected President. The capital stock of the company is $95,000.....A mitre planing machine company has been established at Erie, Penna..... The manufacture of artificial ice is quite an important industry in Georgia.....The gas escaping from the wells is utilized at Warfield, Martha county, Ky., lighting up the salt works..... The Cleveland *Trade Review* says: "The Union Steel Screw Company is employing 200 hands, about one-half of whom are women. The works have been running full since August 1st, and produce about five thousand gross of screws per day..... The pottery furnaces at East Liverpool, Ohio, use natural gas for fuel, houses are lighted and warmed with it, and cooking is done with it at the cost of $1.50 a month. Wells are sunk, and the gas comes up with great pressure, which is collected in a gasometer, and distributed in the ordinary way.....The water of Salt Lake has risen 14 feet since the Mormons settled in its valley.....The directors of Philadelphia City Trusts have decided that "there should not be an extension of the Warden's line until there had been a United States survey of the river front, as it may cause a change in the channels of the river.....Prof. Grant, of Edinburgh, giving an idea of the immensity of space, estimates that a locomotive moving fifty miles an hour continuously, would reach the moon in 6 months, the sun in 200 years, and the nearest star in 42,000,000 years.....Botanists will be pleased to learn that if plants be dipped in a warm mixture of one part of hydrochloric acid and 600 of alcohol before being placed for herbarium purposes, they will retain their natural colors.....A very thoughtful suggestion is made by the Boston *Globe* to gather and put in contact form the reports of the foreign delegation who visited the International Exhibition. We might find in them a most profitable and instructive result of the great show.....The University of Pennsylvania has extended to women the privilege of instruction in the advanced subjects of general chemistry, physics and history.....The Princeton exploring party has returned from a successful tour of two months in Colorado and Wyoming.

EDITORIAL CORRESPONDENCE.

EDITORS POLYTECHNIC REVIEW:—

In these times, when every honest and patriotic man is anxious to do his share towards resuscitating our languishing industries, manufactures and commerce, it is certainly not less than an infamy to work against these exertions.

The writer of this was informed, by a reliable gentleman, that a well-known engineer, of this city, on being asked by a Cuban sugar planter where he should get his machinery built, had advised him to go to England, as now there was not an establishment in this country that could supply first-class machinery of this kind.

I think it can be positively asserted, and it is well-known to engineers in the sugar business, that in this city, as well as in New York and other cities, there are machine works that can supply a planter with a first-class sugar mill, superior to either English or French makers. ENGINEER.

BIBLIOGRAPHICAL NOTICES.

SANITARY ENGINEERING. A series of lectures given before the School of Military Engineering, at Chatham, 1876, by J. Bailey Denton, M. Inst., C. E., &c. E. and F. N. Spon, London and New York, 1877.

We have received and formerly acknowledged the 8vo. edition of 420 pages, with cuts and 23 folding plates. The work is remarkable for its thoroughness and accuracy. It is divided into five parts, treating respectively of Air, Water, The Dwelling, The Town and the Village, and Disposal of Sewage. The first division treats of the constituents and attainable standard of air, the quantity required for human beings, of oxygen, carbonic acid, and foreign matters in air of agencies counteracting the pollution of air, the nature and injurious effects of ground air, malaria and the proper remedy by underdrainage as distinguished from the Italian's raven scheme of "bonification" by warping; carbonic acid as the measure of impurity of air; the duty of the engineer to govern the condition of air by drainage; comparison of dry and wet subsoils, showing the advantage of the former in promoting public health, and giving an improved temperature of the atmosphere and soil.

Treating of water, the author defines its constituents in the normal state; shows the causes of its pollution when in vapor, rain, and springs and streams; states the quantity required for consumption and use; the amount provided in the rainfall, and the proportions which run off which are absorbed by and which evaporate from various soils, &c., in different seasons. Waters are classified and analyzed according to source, and are divided into wholesome (spring, deep well and upland surface) suspicious, (stored rain and surface water from cultivated land), and dangerous (river water with sewage, shallow well water). It is shown that further investigation into the water question is imperatively required.

In the division relating to the dwelling the site is discussed; the importance of drainage in contradistinction to sewerage is entered into; the distinction between drains and sewers (so entirely neglected by so many, and strangely by even Prof. Carfield, whose works on water supply and on sewerage we recently noticed), laid down emphatically. Among other points discussed are the capacity of different soils for retention of water, and the influence of wet soils upon the sanitary condition of cellars and basements, modes of drainage, "damp courses" in walls, distributing liquid and other refuse, (this being treated with especial thoroughness, and being copiously illustrated); water supply for dwellings and domestic filtration. An epitome of the principal sanitary objects to be gained in any dwelling is given.

Under the head or Town or Village, are given general observations on the duties of the engineer in relation to their sewerage; the question of surface and subsoil waters and their admission to sewers noted; the influence of road detritus in affecting the disposal of sewage discussed. Sewage proper, dependent in quantity upon population; local and special trades and water supply is considered, concerning its diurnal variation in quantity; the liquid portion to be removed by the sewers distinguished from the solid refuse to be removed by the scavenger. (We regrrt the importune question of odorless excavations should have been slighted, and hope that this omission will be remedied in the future editions, which the work deserves). The general arrangement of sewers, and the importance of determining the mode of disposition of sewage before fixing the main outfall or intercepting sewers are discussed. Hydraulic questions of shapes and sizes of sewers and velocities of sewage streams are considered and tables given, and the engineering questions of size, shape, material and appliances, &c., are fully entered into and thoroughly illustrated, while sewer ventilation is not neglected.

The treatment and disposal of the sewage of Towns and Villages is the last and doubtless the most important division, and no satisfactory synopsis of it could be given here, as the matter is too valuable to be condensed.

Throughout, the whole work is evident the most careful and wide-searching compilation from official and other sources, if tabular and other matter not readily attainable; and the author deserves our substantial appreciation for having accomplished such an important an undertaking in so satisfactory a manner.

SELECTED LIST OF U. S. PATENTS.

AUGUST 21, 1877.

Patents granted August 21, 1877, 222. Reissues, 9. Designs, 6. Trade Marks, 36. Labels, 4.

194,290. HUB-BORERS. Ezra Caswell, Lyons, N. Y.

The hub is firmly clamped and held by means of an upper clamping-ring, provided with curved arms, which support a socket, and having longitudinally-adjustable gages. The lower clamping-ring attached to the upper by screw-bolts, and provided upon its under surface with a packing-ring of soft material, and having upon its periphery slotted lugs, which embrace the upper-ring, keep the two centered, and form bearings for adjusting-screws, provided with blocks, which embrace the spokes, and press them against the packing on the lower-ring while being bored by a suitable cutter attached to a screw-shaft working in a circular bearing, having its interior threaded, and turning loosely in the socket upon the upper clamping-ring.

194,299. PROCESS FOR PREVENTING THE FOULING OF GAS LIME. F. A. Genth and G. F. Barker, Philadelphia.

The process of preventing the fouling of gas lime, or the imparting thereto of an offensive odor in purifying gas, which consists in passing the gas through sulphuric acid, or a suitable porous material charged therewith to deprive it of ammonia, &c., before passing the gas through lime.

194,307. PERIPHERAL FORCE-FEEDS FOR GRAIN-DRILLS. A. J. Martin, Springfield, Ohio, assignor to P. P. Mast & Co., same place.

Within the feed-cup is mounted a feed-wheel, composed of two vertical flanges, having channels or ribs for feeding out the grain. The quantity discharged is governed by a gate, the forward end of which is arranged to move inward to divide the moving stream, allowing a part to be discharged, while the other continues its course within the cup past the gate.

194,311. UNIVERSAL CHUCKS FOR LATHES. O. Plummer, Worcester, Mass.

The gear-ring, for causing a simultaneous movement of all the jaws, rests upon pins, which are operated upon by cams on a ring, to bring said gear-ring into connection with the pinions on the jaw-screws. When the gear-ring is not raised, each jaw may be adjusted separately. Improvement on Horton's chuck, patented November 13, 1855, No. 13,787.

194,314. WINDMILLS. George S. Strong, Springfield, Ohio.

This wheel is adapted to be deflected by the force of the wind from a position at, or nearly at, a right angle to the tail-vane to one at, or nearly in a line parallel with, said vane, for throwing it out of the wind. There is, in combination with the wheel, a sliding weight, adapted to be moved automatically back and forth or out and in on its supporting-arm by the movements of the wheel itself, in such manner that as the shaft of the wheel is deflected from a position in line with the vane the resistance to its further deflection will be increased, and *vice versa*.

194,319. MACHINE FOR CUTTING AND STICKING MATCH-STICKS. McC. Young, Frederick, Md.

Blocks of wood of suitable form and size are placed side by side upon guideways in a feeding-trough attached to the main frame, and automatically fed to a series of adjustable knives secured in a knife-stock, mounted in a vertically reciprocating gate, by which a series of match splints are cut. They are then automatically carried up and fed into a series of perforated plate arranged side by side, and progressively fed through and out of the machine. A wind-trunk is attached to the carriage-frame near the cutters, for carrying off the small slivers of wood to prevent clogging.

194,335. BARREL TRUSSING AND HOOPING MACHINES. Mark L. Deering, Cleveland, Ohio, assignor of one-half his right to G. H. Hopper.

The barrel is supported on a vertically-movable platform, by which it is elevated into contact with dependent arms supported by a superposed head. The upper part of the head is rotatable and is provided with inclined slots, into which the ends of the arms project, said arms being fulcrumed near their mid-length, so that by rotating the movable part of the head the lower ends of the arms may be moved closer together or farther apart to suit the size of the barrel.

194,343 STAMP-CANCELING DEVICES. C. C. Egerton, Baltimore, Md., assignor of two-thirds of his right to W. S. Richmond and H. Richmond, New York city.

The screw holds the canceler and drives the tangs into the barrel through the stamp. The screw cannot be unscrewed without revolving the canceler, which, by its tangs, cancels the stamp. The spring operated serrated disks serve to hold the screw when it is turned in one, but loosen their hold when turned in the opposite direction.

194,374. PLOW-FENDERS. J. B. Rubsam, Springfield, Ohio.

Constructed with a sharp point and oblique edge to run under the leaves of plants, and raise them above the falling earth. The beam-clamp comprises an eccentric ratchet-plate, to adjust the distance from the plow, and various holes in the plate and a stud upon the beam, to regulate the height from the ground. A hinged cut-off regulates the quantity of dirt thrown around the plants.

194,389. CHAIRS. Harwood Wakeman, New York, N. Y.

The seat is composed of two frames united, one covered with cane and the other upholstered, the frames being removable, in order to bring either surface uppermost. The arms may also be revolved on dowels, to bring the upholstered part underneath, to protect it from injury when not in use. The seat frame and posts are perforated for ventilation. The back may be removed by taking off the cap piece, and may be reversed or removed entirely, to allow a permanent backing to be used.

194,393. HORSESHOE-NAIL MACHINES. H. E. Woodford, Montreal, Quebec, Canada.

The disk carrying the graduated rolls for drawing the nail-blank is also provided with a projection on its periphery for operating the cutters, which, at the proper time, are brought in position to sever the blank. One cutter is fixed in the side of the anvil, the other to a pivoted arm connected with the anvil, with which said arm advances and recedes, bringing its cutter in position to act, and again withdrawing it from the path of the graduated rolls.

194,396. RIVETING MACHINES. J. F. Allen, New York, N. Y.

Depressions in the face of the hammer at right angels to its narrow striking-surfaces allow the metal of the rivet-head to spread when struck. The narrow striking-surfaces act upon each part of the rivet, in virtue of the continued turning of the hammer by the mechanism specified in the first claim, and eventually produce the finished head. An adjustable foot, provided with a steady-pin, which enters one of the rivet-holes, supports the machine upon the work, and the machine is connected to the anvil-block by a bolt, that passes through one of the rivet-holes and into a slotted arm projecting from the said anvil-block.

194,412. CARDING-MACHINES. F. Christen, Homestead, Iowa.

Improvement upon English Patent No. 9,769, of 1843. The fleece is taken from the main cylinder by a doffer having several independent rings of card-clothing, which, after leaving said doffer, pass alternately over upper and lower delivery-rolls, and present uniform slivers for removal by the doffer-knives. A dividing-roller, provided with rows of teeth to register with the spaces between the rings, and lay the fibers evenly thereon, is located beneath the doffer. The tension of the bands or rings is regulated by the adjustability imparted to the bearings of the delivery-rollers.

194,422. PROCESSES FOR TREATING MINERAL WOOL. A. D. Elbers, Hoboken, N. J.

The process of preparing mineral wool, which consists in mixing the mineral wool while in a heated condition with bituminous, gummy, or resinous substances while in a vaporized condition, substantially as described.

194,422. APPARATUS FOR BENDING AND HARDENING MOLD-BOARDS. D. Franklin, Tama City, Iowa.

The bending-dies and hardening form are provided with corresponding interchangeable guide-pins, situated so as to enter the bolt-holes on the edge of the mold-board. By changing the position of these pins different shapes may be imparted to the blanks, and duplicates of any given shape may be bent and hardened. The blank is first bent, and then, while yet hot, is transfered to the hardening-form, clamped therein, and water, under pressure, made to flow through the form.

194,445. TURBINE WATER-WHEELS. C. Krogh and C. O. Krogh, Kroghville, Wis. [Filed April 21, 1877.]

When the gates are opened the water from the flume passes through the channels between inclines, and strikes the buckets and passes out, forcing the wheel around. A certain quantity of water is always carried around with the wheel, which, by the centrifugal motion, is forced against its outer walls, thus creating considerable friction. This is compensated for by the conical shape of the turbine, the power of which is in this way increased considerably.

194,461. MACHINES FOR MAKING HORSESHOE-NAILS. D. I. Pruner, McVeytown, Pa., assignor to himself, A. S. Valentine, G. Valentine, and G. A. Fairlamb, same place.

Die-rollers form the rod into a series of connected (heads and points) blanks. Emery-wheels remove all irregularities left by the forming process, and a shear co-operating with a stationary bed-die trims and points each nail, and severs it from the rod. A pawl, operated by the shear-carrying plunger, feeds the rod forward. A V-shaped plate, backed by a spring, acts to discharge a nail that adheres to the shearing-die.

194,501. PROCESSES FOR THE PRODUCTION OF CARBONIC-OXIDE GAS FOR HEATING AND WELDING. William S. Sutherland, Coombs Wood, Halesowen, England.

In the manufacture of carbonic oxide, the process herein described, consisting in heating the incoming air by the outgoing products of combustion, whereby radiation and loss of heat from the producer are prevented, and the fuel is burned with a supply of air insufficient to produce carbonic acid, substantially as specified.

194,506. TIME-LOCKS. J. Burge, Circleville, Ohio, assignor, by mesne assignments, to the Yale Lock Manufacturing Company, Stamford, Conn.

An oscillating notched dogging device, isolated from the time mechanism, and the spring-actuated gearing for oscillating it, and time mechanism for determining the time of setting into action the spring-actuated gearing for oscillating the dog for unlocking, and devices for connecting and operating the parts.

7,857. RINGS FOR RING AND TRAVELER SPINNING-MACHINES. J. W. Wattles, Canton, Mass. Patent No. 75,610, dated March 17, 1868; Reissue No. 3,165, dated October 20, 1868.

The bore of the receiver is eccentric to its outer circumference. Said receiver is split through, so as to be capable of being sprung or contracted upon the shank of the ring by means of a screw inserted in the rail, which screw is also employed to confine the receiver in the socket of such rail.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, OCTOBER 6, 1877. No. 14.

DROUDE'S DYNAMOMETER BRAKE.

This is a device intended to test the power applied on the screw-shaft of a steamer. The ordinary, or Prony friction brake, measures the resistance of friction between two solid bodies revolving in contact. Its chief defect is that at very high speeds and pressures the friction of the rubbing surfaces causes intense heat. The power is measured by the diameter of the drum at the effective radius, multiplied by the weight on the lever, multiplied by the number of revolutions; a variation in power affecting the speed of rotation. Its work is practically hoisting a weight out of a well of infinite depth. The Froude brake measures the power by a multitude of reactions, caused by a sort of turbine rotating in a water casing; jets of water being dashed from projections on one, against projections on the other, when they are again dashed against the first surfaces. In the cuts (which we take from *Engineering*,) *AA* (Fig. 1) represents the screw end of the shaft; *BB* the turbine, which is a sort of disc or circular plate, having near its periphery a circular channel semi-elliptical in section. (For measuring 2000 *HP*, this disc is about five feet in diameter). In Fig. 2, Fig. 1 is repeated, with the casing *CC* at the front; *DD* at the back. The face carries a channel similar to that on the disc; the back embraces the disc, almost touching it. There are fixed semi-circular diaphragms (see Fig. 3,) placed obliquely so that their semi-circular edges fit the elliptical outline of the channels, the diameters spanning the major axis of the ellipse. Fig. 4 shows one edgewise. Each half channel has 12 diaphragms, making obliquely placed circular wells, of which one-half moves past the other, so that the moving half would appear to be moving against the other. The water is urged outwards in the turbine and inward in the casing, making a continued current. The streams enter each well, and leave it with the same velocity reversed; this force, due to the reversal, being proportionate to the amount of momentum reversed per second. The product of the mass and the change of speed is equal to thrice the speed of the turbine. The mass is as the mean speed of the vortex currents in the cells, so that the tendency of each vortex is as the square of the speed of the turbine. Roughness of the walls *diminishes* the friction of the currents upon each other. The action may be compared to that of a locomotive with elastic front approaching an elastic wall, an elastic ball rebounding between the two approaching surfaces. The capabilities of absorption of power of the turbines are as the fifth powers of the disc diameters. By sliding shutters their friction is increased or diminished so that the same turbine answers for 2,000 *HP*. with 90 *Rpm.*, or for 340 *HP*, with 120 *Rpm.* The lever is a triangle, having for its base the diameter of the casing, and for its other sides a spar and a wire-rope, (See Figs. 5 and 6.) Fig. 6 shows a two-faced turbine, giving double the resistance. There is a suitable integrating apparatus and register, properly connected with the shaft and with the brake lever.

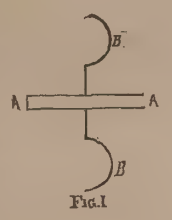


Fig. 1

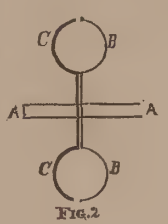


Fig. 2

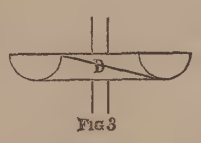


Fig. 3

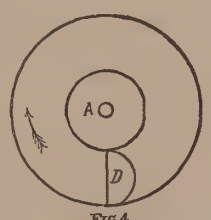


Fig. 4

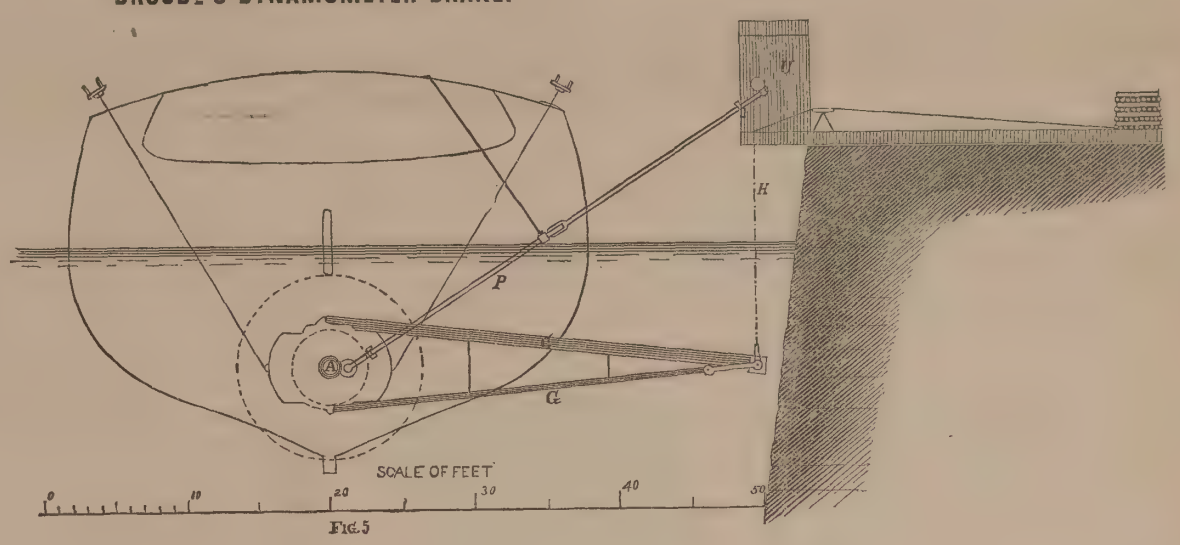
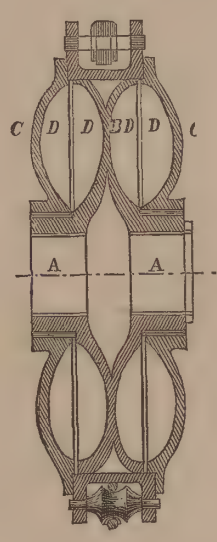


Fig. 5



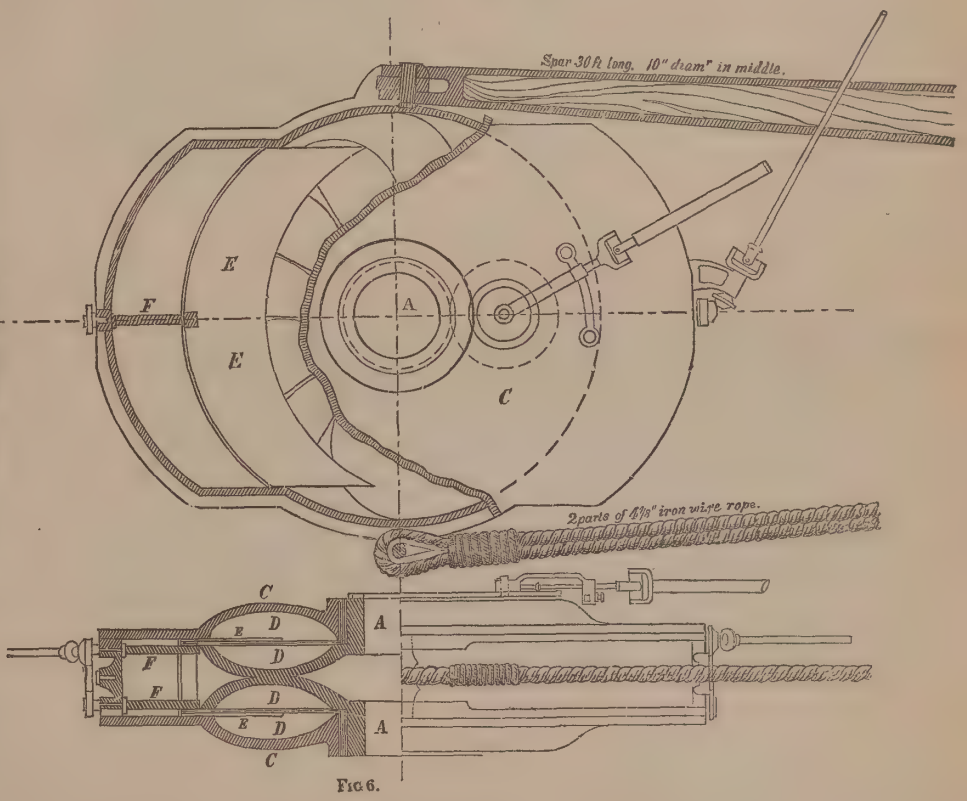


Fig. 6.

An illustration, given by Mr. Froude, of the "power of current growth" in the dynamometer cells, is as follows: If a jet of water issues from a nozzle at *a* with velocity 10, is caught by a fixed bent tube of the same diameter as the nozzle. The water enters *b* with velocity 10, being discharged at *c* with the same velocity, while tending to force the bend away from the jet. If the bend is moved towards the jet with velocity 1, the water enters it with velocity 11, but leaves it with velocity of 11 relatively to the bend, but of 12 relatively to a fixed point. If on leaving *c* it entered another bend, moving to meet it, the velocity and resistance would be further increased, and so on *ad infinitum*. The cells in the Froude brake represent just such a series of moving bends; and its great power as a brake can be readily imagined. The device is at once a great triumph of pure theory, and a wonderfully practical and useful invention. G.

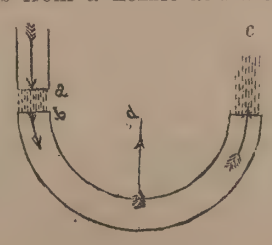


Fig. 7.

INCREASE IN ADVERTISING RATES.

After our issue of October 20th, our advertising rates will be reckoned by agate measurement, (fourteen lines to the inch) instead of nonpareil, (twelve lines per inch) as at present. Under the headings "Patents for Sale," and "Special Notices," these rates will further be increased to twenty-five cents per line, instead of twenty, as now. This increase will not affect contracts made before the date mentioned.

Our rates will still be the lowest of any reputable technical journal in the country, circulation not considered; and when we consider that THE POLYTECHNIC REVIEW has the second largest circulation of papers of its class in America, and that this circulation is nearly entirely among heads of manufacturing firms, and that the number of advertisements is limited, the extreme cheapness of the REVIEW as an advertising medium cannot be questioned. Further increase may be expected about January 1st, when the REVIEW enters its Fifth Volume.

ANNOUNCEMENT OF ARTICLES.

Next week we shall commence a series of practical articles by PROF. S. W. ROBINSON, of Illinois State Industrial University, illustrated by twenty figures. The four illustrated articles on Machine Kinematics, previously announced, are now prepared. A series of twelve articles on the manufacture of Leather, by Lewis S. Ware, C. E., has been written and is in the proof-reader's hands. PROF. SWEET'S "Tools and their Uses," will be continued. We shall shortly announce other interesting articles.

"TEN MINUTE" PAPERS.

BY PROF. J. E. SWEET.

TOOLS AND THEIR USES.—XI.

One of the most important features of the modern lathe is the slide rest, in fact, it was the addition of the slide-rest to the hand-lathe that gave to it the significant name of "engine lathe." The method of guiding the slide-rest is a subject that has received a good deal of thought from men eminently sound on mechanical subjects, scientific and practical men, who have had an abundance of experience, and with whom to differ requires a good deal of self-confidence.

The different methods employed are, the flat top shears, that is a bed with a flat surface upon which the rest slides, and to which it is held by gibs, usually hooking under the two outer edges at an angle of some 60°. This is the method employed by the English makers, by Sellers, by the Freeland Tool Co., and by Ferris and Miles, and possibly by some other American makers. The second method is that employed by nearly all the other lathe makers in the country, and consists in providing the upper surface of the bed with two inverted V's upon which the slide-rest slides; and upon which it is, in some cases, held down by means of a weight; in others by means of gibs, and in still others by rollers secured to a stiff spring, which is a device having nearly the same effect as a weight, and possess in addition some constructive advantages. The third method, which some might call a compromise, but when thoroughly considered will be found as different in principle from either of the others as they are from one another. It consists in carrying the slide on an inverted V at the front and in a flat way at the back, and in holding it down by gibs working against horizontal surfaces on the under side. This method has been used by Hughes & Phillips for years, and possibly by other firms in Newark. Makers of lathes from these different plans believe their style the best, and they are all right under certain circumstances, but wrong under others. The slide-rest has at least three offices to perform, and there are three kinds of work or more to do. One man may be an engine builder, and constantly use a lathe its entire length on the largest work it will swing. He may, with an English lathe, do one and a half or twice the work he could on any New England lathe; whereas, if the same two lathes be set to turning bolts or any light irregular work, in which ease of manipulation is the great requirement, the New England lathe will easily turn out two to one. Again, the work may be such as requires absolute accuracy, a requirement which the third form of bed can be made to fill better than either of the others.

I doubt if it is possible for a man to state the advantages of a system he does not believe in, as fairly as he can those of the one he does. Nor can he see the disadvantages of his own favorite as plainly as he can those of other sorts. Therefore in following this argument, you will need to make due allowance for my enthusiasm if you would arrive at an impartial conclusion.

What is wanted of the guides to the slide-rest is, 1st, something that compels the slide to travel in an absolute line with the central axis of the lathe.

2d. The slide must travel freely in all positions, and yet be free from side play or shake; also, be free from vertical play at the back of the lathe, and, however it be attained, the arrangement that will maintain these conditions the greatest length of time is in that respect the best.

The strains that tend to wear the ways out of true are, 1st, a downward one at the front of the lathe. 2d, sometimes up and sometimes down at the back. 3d, a side strain about nine-tenths of the time, in a direction towards the operator, and the remainder of the time, or when boring holes, from him. Besides these strains there is another, a twisting strain caused by the propelling power, usually more destructive than either. The slide-rest in traveling the ways meets with two resistances. Were these resistances constant in regard to quantity and position, and could the propelling mechanism be located in the right position, so the two would balance each other, the twisting strain could be avoided. But as it is not practically possible to put the screw or rack between the cutting edge of the tool and the sliding surfaces, there is an unavoidable strain tending to twist the slide-rest around with the point of the cutting tool as a centre.

First let us consider the strains due to the cut of the tool. Let the diagram, Fig. 17, represent the end section of the lathe with a piece of work in, and the tool in action. If the tool is level with the centre, and so sharp as to cut without any tendency to slide away from the work, the strain would be down and divided between the two ways, though more on the front way than on the back, varying in proportion as the size of the piece varies. The weight of the slide is also carried by both ways, and also more on the front than back, because it is as usually made the heaviest at the front. Now as tools are as often set above the centre as level with it, and as tools always get dull before they are ground and sometimes crowd away from the work, the strain instead of being vertical, inclines more or less towards the operator in turning, and more or less from him in boring. In all cases the strain is greatest on the front way, so the propelling power must, to be the nearest the resistance, be on the front side of the lathe. I have said the strain would always be the greatest on the front way, but in certain cases it may not be so. In boring, if the tool is dull enough, the strain may fall above the back way, to such an extent even as to lift the front of the slide. A workman using a tool that dull, would be likely to use a turning tool equally dull, hence these strains, so far as they have a tendency to wear the lathe, would in a majority of cases be towards the operator. Moving the slide-rest back and forth, subject to these strains, tends to wear the ways, and the slide being used more at one part of the lathe, this wear works the surface of the way out of true. Other things being equal, the wearing surface will be the most enduring that is nearest to a right angle with the strain falling upon it. This is, I think, one of the claims made by those advocating the flat bed. But as has been shown, the majority of the strains are not straight down, but in a direction towards the front of the lathe, then the flat bed is not at right angles with the strain; and farther, if the strain varies from the vertical as much as 22½°, it is no nearer right than is the inside of a 45° angle V.

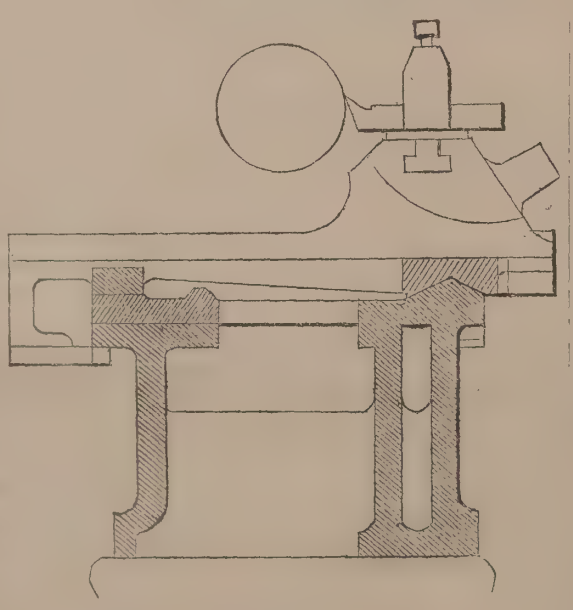


Fig. 17.

Let us see what effect the wear has towards throwing the lathe out of true, and which of the three plans is the worst in this respect. In the flat-top bed the wear of the top of the bed in front, the slight wear on top at the back, and the direct wear on the undercut gib at the back, each contributes toward throwing the point of the tool away from the work. The wear of the gib on the front, when boring, does in no way counteract any of this tendency. Next let us look at the case where a single V is used. Admit the inner side of the V to be worn away to the same extent that the gib is, in the case of the flat top, the slide falls in consequence, but the slide is brought forward to only one-half the extent it is in the other case, beside what wear there is downward at the back contributes toward conteracting the evil resulting from this; and farther, the wear in the opposite direction also contributes toward contracting the greater wear to whatever extent that may occur.

In the case of the slide working on two V's it is worse, because the additional wear in front must tend to slide the back side up the incline, and raising the back side tends to throw the point of the tool from the work. Assuming the wear to be equal, the evil results arising from it is less in the single V than in either of the others. Other things being equal, the wear on the sliding surfaces will be least on those that are most generous in size. The claim made by the advocates of the flat-top is, that they are the only ones having the proper amount of wearing surface. While this may be true as lathes are made, it need not be so, for there is as much room to put on a V as there is a flat-top, beside, there is scarcely a limit to the length a slide-rest can be. I hope to be able to show that two objects can be gained by getting generous wearing surfaces, endwise of the lathe, while only one can be shown by making the surfaces wider. And farther still in this respect, I am firmly of the opinion that the V can be kept cleaner and better lubricated than the flat-top. The longer the sliding surfaces are the better they can be kept.

Next let us consider the result of lost motion due to wear. In the case of the flat-bed, the wear on the two sides of the bed from turning and boring are added together. So that whatever is worn away allows of rather more than that amount of lost motion. And if the gibs are set so free that the slide can be run over the unworn part of the bed, it will have shake or play on the worn part. If the gibs are set up tightly on the worn part, the slide cannot be traveled the whole length of the bed. With the single V there is no side shake possible. The only one is a vertical shake at the back. which must be small because of the wear at the back of the lathe must be small; This shake at the back would be slightly greater with a V at the back than with the flat slide.

To be continued.

EMERY WHEELS.

Of late years the use of emery in the machine shop and other manufactories of metal, has become very general, not confined, as formerly, to its application with oil, by means of cloth or emery paper, or to the polishing of a few articles by the use of a wooden wheel faced with emery; but wheels of solid emery, of all sizes, of different degrees of fineness, of varying states of hardness, and of shapes adapted to particular jobs, are used in every shop where pretensions to rapid and economical work are made. The variety of the applications of emery is too great to be fully stated without prolixity. It is sufficient to say that this material has, in a very great and economical measure, taken the place of the file and of the hard labor of draw filing and hand polishing. Articles of iron or steel, just from the lathe or planer, are placed on the emery wheel, and, in a small portion of the time hitherto required, brought to the requisite polish and finish. Every shop has its sets of wheels and usually a polishing room where all this description of work is done. There are a number of manufactories of solid emery wheels, bearing different names and laying claim to particular excellences; one shop, or concern, will affect one make, and another will swear by a different favorite; but in most shops the old-fashioned wooden wheel, with its leather face and emery dressing, is preferred for some descriptions of work, and for fine polishing nothing is accepted as superior to a wheel made of the hide of the hippopotamus or the walrus, and even wheels of cotton cloth are used with cake emery. But the modern uses of emery are not confined to polishing or surfacing; the emery wheel is applied to the same use as a rotary cutter, which, in reality, it is, and a very efficient one, too. The range of its work is surprising to one whose acquaintance with emery is limited only to his experience in the machine shop of thirty years ago. Among its applications are gumming saws, (*i.e.*, cutting away the material between the teeth), dressing castings, trueing the surfaces of cylindrical bodies of hardened steel, finishing forgings, grinding lathe and planer tools, the heavy knives used by curriers in splitting sides of leather, grinding straight or spiral tooth rotary cutters, drills, fluted reamers, taps, dies, tools for cutting mouldings, chisels, gouges, planer knives, paper cutting knives, and the blades of scissors and fine pocket cutlery. In addition to these, the emery wheel, properly arranged on a frame adapted to the purpose, may be used in place of a planer in finishing from the forge gibs and keys, and other articles requiring a perfectly plane surface. The depth of the cut of the wheel's surface can, in such cases, be as accurately gauged and determined as that of a steel cutter. A soft emery wheel, or one where the emery is secured to an elastic surface like leather, is sometimes used to draw the temper of small hardened steel articles.

In home-made or dressed wheels of wood and leather, or of hide, the emery is secured to the surface by hot glue, or by a solution of gum shell-lac in alcohol, but in most solid wheels the entire wheel is made of emery, held in place by a substance that gives cohesion to the mass, solidity being assured by immense pressure and proper drying. The material used to cohere the particles of emery varies with different manufacturers, and in some cases its composition is held as a trade secret; but combi-

nations of glue, lac, caoutchouc, and similar substances, with modifying ingredients, are in use. Lately the new composition of gum camphor and cotton, known as celluloid, has been advantageously employed, some who have tested wheels made with it against those of other compositions, claiming that it outlasts all others and does not glaze so readily. When any emery wheel glazes it must be turned, which at first sight would seem to be an impossibility, when it is considered that the emery itself is so hard that it is used for the dressing of almost all the precious stones except the diamond. But the diamond, in one of its forms, is the very material used for turning and trueing the emery wheel. The variety used is the massive, known as *boart* or *bort*, or black diamond. One of these particles is fixed in the end of a bit of steel, as is the diamond of a glazier, and is used against the wheel precisely as a chisel, gouge, or hand-tool in turning wood or metals. One variety of the solid emery wheel, however, known to the trade as the vulcanite, does not require the diamond tool, but is turned and trued either with a red-hot iron, or an ordinary turning tool, the surface of the wheel being warmed, as it revolves, by means of a spirit-lamp or gas jet. Emery is nearly pure alumina, of the same nature as the sapphire, small sapphires being frequently found in corundum, or adamantine spar, a purer and harder quality of emery. To its hardness and the angularity of its crystals is due its value as a cutting material for reducing metals, and this angularity remains even in the flour of emery, which is so fine as to be an impalpable powder, giving no sensation of grittiness when rubbed in the fingers.

The Union Stone Company, Boston, Mass., manufactures solid emery wheels, which contain no glue, shell-lac, rubber, or other gummy substance, which are free from smell when in use, require only three-fourths the speed at which emery wheels are ordinarily run, thus being adapted to foot-lathes and preventing the drawing of the temper of cutting blades, and are adapted to brass as well as harder metals. They are made up to seventy-two inches diameter, and of twenty-four grades of emery, fitting them for all descriptions of work, from cleaning castings to grinding edge-tools. They are made to be used either with or without water, or with oil, and do not glaze. They are used in place of the grindstone, and are made in forms to suit every size and description of tools, such as gouges and moulding cutters. The different styles of wheels made by this Company are adapted to tool grinding, circular saw gumming and sharpening, cleaning castings, trueing surfaces (taking the place of a metal planer), grinding milling tools, straight, taper, or spiral; trueing lathe centres, finishing brass castings, grinding twist drills, reamers, and many other purposes. The Company makes also oil-stones of emery, of varying grades, intended to take the place of the ordinary whetstone hone and oil-stone, and rub-stones for cleaning castings and removing scale. These are made in shapes to adapt them to any class of work. Grinders with automatic feed are made to grind blades up to eighty inches in length, and a similar hand machine for carpenters' use, having automatic feed and arranged to give a straight, convex or concave edge is manufactured.

JESSE H. LORD.

SULPHATE OF COPPER BATTERIES.—III.*

The Gravity Battery.—In consequence of the inconvenience experienced in the use of the Daniell battery from the deposits of copper upon the porous cell, Cromwell F. Varley, in 1854, endeavored to discover some process by which it could be suppressed altogether without diminishing the force of the battery or lessening its constancy. In this effort he was entirely successful, for after a series of experiments he found that the difference in the density of pure water, or water charged with sulphate of zinc, and a solution of sulphate of copper, was sufficient of itself to cause an entire separation between them when placed in the same vessel. Accordingly he constructed his battery (Fig. 9) by suspending a cylinder of zinc near the top of a glass jar, and placing a copper plate at the bottom, and then filling the jar with a saturated solution of sulphate of copper and a diluted solution of sulphate of zinc. The difference in the specific gravity of the two solutions causes them to separate at once and become superposed in the jar, the sulphate of copper occupying the lower and the sulphate of zinc the upper portions of the jar.

Fig. 9.

The chemical action which takes place in this battery is the same as in the Daniell. The zinc cylinder is oxidized by the oxygen of the water, and the oxide combines with the acid set free by the solution of sulphate of copper, forming sulphate of zinc, which remains in solution, while the oxide of copper, which was previously combined with the acid, being set free, is reduced to metallic copper, and is precipitated on the surface of the copper plate at the bottom of the jar. The reduction of the oxide to the metallic state takes place in the following manner: The water of the solution furnishes oxygen to the zinc, and thus enables it to combine with the acid; while the hydrogen, which is liberated, again forms water with the oxygen of the oxide of copper, with which it comes in contact, leaving the metal free. Hence, but little gas is given off during the action of a battery charged by sulphate of copper, as the hydrogen is in this case mostly absorbed.

In order to reduce the resistance of the gravity battery, the horizontal copper plate is now supplemented by two vertical copper plates, forming a ×, and projecting about three inches from the bottom of the jar.

In charging the battery the copper frame is placed on the bottom of the glass jar, and the jar filled with sulphate of copper to the top of the copper frame, and the water to within an inch and a half of the top of the jar.

The battery must then stand until the sulphate of copper and sulphate of zinc dissolve and separate. When the two solutions have properly separated the lower part of the jar will contain a blue fluid, and the upper part a nearly colorless or transparent fluid. After the separation of the two fluids (which will require about forty-eight hours) the brass frame for holding the zinc must be placed on top of the glass jar, and the zinc suspended near the top. The zinc should always be suspended in the colorless or transparent fluid.

In case the zinc is placed in the jar before the two solutions have separated, copper will be deposited on the zinc, and the action of the battery be retarded. When such deposits take place the zincs should be removed and cleaned with a stiff brush.

As the sulphate of copper becomes dissolved and consumed the blue solution will decrease, and the zinc should be lowered from time to time, so as to reduce the internal resistance.

When the water in the upper portion of the jar becomes saturated with sulphate of zinc, the sulphate crystallizes upon the zinc plate, stopping the action of the battery. The conducting power of a solution of sulphate of zinc is greatest when diluted with an equal quantity of water. Part of the solution, therefore, should be from time to time removed and replaced by water.

When crystals form on the top and sides of the cell, in consequence of the water being saturated with sulphate of zinc, they should be removed with a damp cloth. A little grease or fat rubbed on the top and sides of the jar, near the top, will have a tendency to prevent the formation of crystals.

When all the sulphate of copper has been consumed the action ceases, and sulphate of zinc will be reduced upon the copper plate as a black powder. It is necessary, therefore, to provide a constant supply of sulphate of copper. Undissolved crystals of sulphate of copper should always remain in the bottom of the jar.

The jars should not be disturbed when in use, as this would cause the solution to mix. As the water evaporates from the jar it should be replenished by a fresh supply. Great care must be taken in replenishing the jars not to disturb the lower or sulphate of copper solution.

Fig. 10.

Two sides of the battery are made, one of which is designed for local batteries and for working from three to five main wires, and the other for working one or two main wires.

The battery should be taken down and cleaned about every four months.

The battery should be kept in a dry and comparatively warm place. The temperature of the battery should never be allowed to approach the freezing point, as this would destroy its action.

The form of gravity battery is shown in Fig. 10, two copper disks are used in place of the spirals.

The Muirhead Battery.—This is a form of sulphate of copper battery, Fig. 11, now in general use for telegraphic purposes in England. The zinc plates are about 4 inches long by 2 inches wide, and the copper plates about 4 inches by 3 inches. The porous

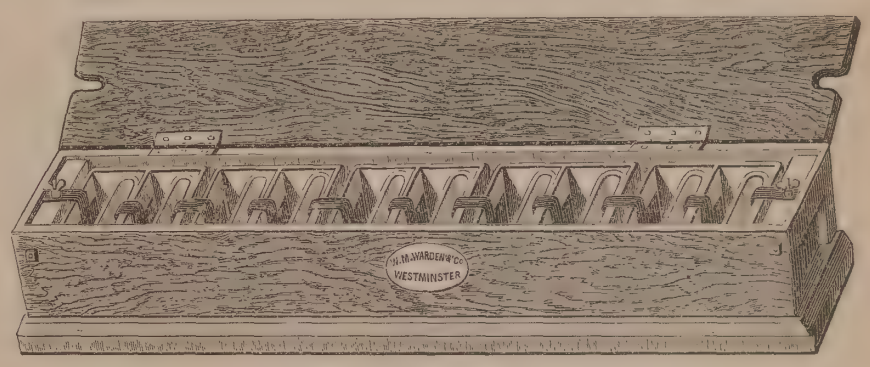


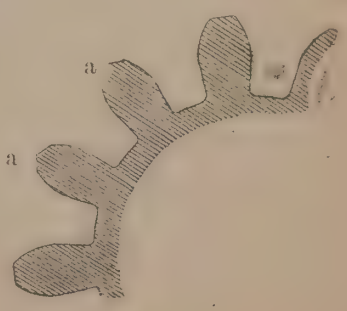
Fig. 11.

cells are filled with a solution of sulphate of copper, and the outer cells, which are made of white porcelain, and in pairs, are filled with very dilute sulphuric acid. Five such pairs are enclosed in a strong tea-wood case, with a lid through which gutta percha covered wires pass at the ends. Crystals of sulphate of copper, of the size of a hazel-nut, are placed in the porous cells to maintain the solution in a saturated condition. The copper connecting strap is cast in the zinc, having been tinned to insure adhesion. To check endosmosis, or the tendency of the two fluids to mix through the porous cells, they are greased, except on the portion which is opposite the zinc plate. This, however, does not entirely prevent the mixing of the solutions.

CONCERNING BACK-GEARED LATHES.

Some time since, in requesting our readers to send on for publication such little wrinkles as they may have found of interest and practical value, we made the remark that a one-cent postal card would hold a five-dollar idea. We present herewith an idea, sent on a postal card, and which, we are sure, will be well worth five dollars to the community:

Cutting off the corners of the teeth on the back-gear of a lathe as shown at *a a*, in the cut, will save much time in throwing them in gear, and avoid a great source of annoyance; and a second pass through the gear-cutter with the proper mill cannot be very expensive.



The best method of making the mill or cutter is to make each tooth a plain bevel, but with the angle of the alternate teeth in opposite directions.

J. E. S.

*From "Prescott's Electricity and the Electric Telegraph," (D. Appleton and Co.

HOW WOOD SHRINKS.

Lengthwise shrinking of timber is very slight, but that transversely is much greater and more peculiar. Our constructive woods as oak, pine, &c., are built up of fibrous tubes, ranged in irregular circular layers, bound together by radial plates or rays which the carpenter calls the "silver grain" and the botanist the medullary rays. The effect of seasoning depends on these radial plates, because the fibers cannot shrink laterally without tearing them apart, and hence the timber is split lengthwise in radial plates, and the log maintains its full diameter. If the whole mass of tubular fiber were to contract bodily, the "plates" would be crushed and the wood ruined.

Sawing an oak tree lengthwise, into quarters, before it has commenced to split and contract, the straight sides of each quarter would be equal, and at right angles, or "square," to each other. But after dry storing for a time their sides are no longer "square" to each other, the angle being diminished by the portion shown in black in Fig. 1, and the rays being brought closer together.

If we saw the trunk by six cuts into seven planks, each will behave differently. We show five of them in Fig. 2. The center plank retains the original thickness in the middle, because the rays resists the thrust; and gets thinner at the edges, because there the rays are parallel with the thrust and hence do not oppose the shrinkage. The breadth of this plank in not lessened because shrinkage in that direction is opposed by the rays as braces.

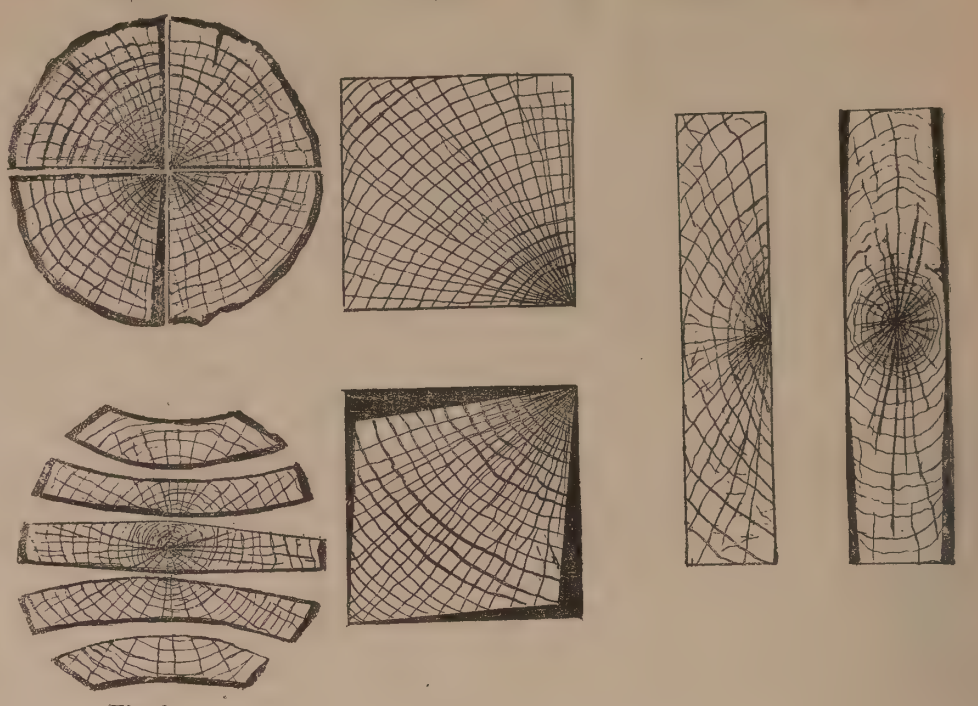
The planks at each side of the centre retain their original thickness in the middle; become a little narrower especially on the outside face, and hence bend from the heart side. The next two are no thinner in the centre, and not much thinner at the edges, but are greatly convex on the heart side, and concave on the outer face.

If one of these planks were cut into prisms when green, the shape of each of these prisms would depend upon what part of the tree it came from. A square from near the outside (Fig. 3) would contract as in Fig. 4; not shrinking in the radial lines but contracting partly in a direction perpendicular to them. The end grain will show from what part of the log a plank is cut; thus Fig. 5 shows one from the outside: and we must expect it to shrink in *width*; Fig. 6 shows one from the center and it must be expected to get thinner and curved, as shown by the black portions.

In very soft wood these medullary plates or rays are not so strong as to entirely resist crushing, and hence the law is not so strongly carried out, as with the hard wood.

If a mast or spar is formed of the round log it will remain round; if made of a quartering it will become oval.

In a future article we will speak of the waste of timber in sawing. G.



THE DISINFECTING VIRTUES OF PERMANGANATE.

The consideration of the question of the relative values of disinfecting agents, which we have carried so far in several preceding articles, as to distinguish in such substances two very distinct forms of action, the one hygienic and the other simply chemical, and of which the chloride of lime and the sulphate of iron (each separately considered in the articles alluded to) may be regarded respectively as typical examples, brings us to the examination of the claims and virtues of a number of other agents, less generally employed, and hence not so well known as those just alluded to, but which nevertheless are well worth study.

Of these, the class of chemical substances, known as permanganates, deserves especial attention; and the permanganate of potassa, being the most commonly known and used compound of its class, we will consider it as the typical representative thereof. The disinfecting virtue of this substance depends entirely upon its extraordinary oxidizing power, the permanganic acid, which is one of its constituents, being very rich in oxygen, and disposed to yield up a considerable proportion of it when brought, under favorable circumstances, in contact with substances susceptible to, or eager for, oxidation. Brought in contact with decaying or putrifying organic matter, the available oxygen of the permanganate is seized upon with great avidity, the carbon, hydrogen, nitrogen, sulphur, &c., that enter, generally speaking, into the composition of such masses, being rapidly transformed respectively into carbonic acid, water, nitric and sulphuric acids, which form thereupon harmless neutral compounds with the potassa and inorganic oxide remaining over, and if enough of the disinfectant is employed, or on the other hand, the quantity of offensive matter small, the arrest of the process of putrifaction will be complete. The destruction in this manner of the menstruum, which has afforded them the means of nutrition and propagation is, of course, attended with the extinction of the vitality of the organized germs that abound in such offensive matters, and which by their dissemination into the air or water, spread contagious diseases broadcast. As a hygienic disinfectant having extraordinary oxidizing qualities, in virtue of which it may be considered in a general way to burn up organic matters, the permanganate is entitled to take high rank. In the general principle of its action, it will be observed, the permanganate resembles the chloride of lime, which, it will be remembered, yields oxygen to organic matters; but, unlike the chloride, it is not of volatile nature, and hence its activity is limited to the disinfection of the matters with which it is actually in contact. For the purification of the infected air of apartments (hospitals, sick rooms and the like), for which the chloride is excellently adapted, the permanganate is manifestly useless. It may, however, be applied with the best results in dilute aqueous solution to the walls, floors, and furniture of infected buildings or apartments.

We may sum up its virtues and usefulness as follows:—When small quantities of contagious matters are to be dealt with, it cannot be surpassed, either in the rapidity or thoroughness of action. When, however, large masses of organic refuse, fecal matters and the like must be treated, it is quite inadequate for the purpose, inasmuch as the available oxygen it contains will be quickly seized upon and exhausted by the excessive quantities of readily oxidizable substances therein, so that unless an enormous quantity of the salt were used its employment would be practically of no avail; and neither the ammoniacal odors, nor those of the more offensive sulphuretted hydrogen would be fixed, unless large quantities of the mineral acids were employed in conjunction with it, a plan that is open to serious objection, as has been pointed out. The high price of the permanganate again would operate as a serious obstacle against such wholesale use, even were it not open to the objection of inutility. As a chemical disinfectant (deodorizer), therefore, the permanganate is not to be recommended.

When, however, small quantities of offensive or contagious matters are to be treated by direct contact, as wells of drinking water, or the walls, floors or furniture of ships, hospitals, sick rooms and the like, the application of the permanganate will be found very advantageous, inasmuch as it combines with an energetic action a total freedom—in virtue of its want of volatility—from the strong and, to many persons, disagreeable odor, which renders the use of the cheaper chloride of lime, and to a great degree of carbolic acid, objectionable. W.

SAFE OIL IN THE HOUSEHOLD.

Neither all that has been written and re-written upon the fruitful theme of adulterated kerosene, nor the existence of much excellent legislation and of numerous officials clothed with authority to execute the laws regulating the traffic in these highly dangerous commodities, has thus far been able to exercise an appreciable influence in effecting a reform, nor apparently have they succeeded in making any noticeable impression upon the popular ignorance of or indifference to the subject which unhappily prevails.

Legislators, proud with the consciousness of having legislated an evil out of existence, return to their constituencies, and governors, gifted with a keen appreciation of the eternal fitness of things, entrust the execution of the law to inspectors whose skill in managing ward meetings or manipulating a caucus is recognized as a preëminent qualification of official capacity.

The competition amongt the refiners of and dealers in petroleum leads them, from motives of cupidity, to systematically violate a law which is practically a dead letter; and until the faithful execution of the law shall educate public opinion to a comprehension of its excellence, we must wait for the remedy. To show in few words how the refiners and dealers in oil are specially interested in maintaining the almost universal practice of adulterating kerosene with unsafe oils, it is only necessary to know the fact that the naphtha (or benzine) which is one of the very volatile and dangerous constituents of crude petroleum, only commands a price from three to five cents per gallon in the market, while the refined petroleum or kerosene commands a much higher price, say from twenty to twenty-five cents per gallon. As it can be done with impunity, we can readily appreciate how strongly the refiner is tempted to turn the heavier portions of the naphtha (which distills off first) into the kerosene tank, when by this simple operation it will bring the price of kerosene; and we can have no great difficulty in understanding why the shopkeeper who buys this adulterated kerosene should imitate the example of the refiner and add another dose of benzine to the already adulterated stuff.

To show how the addition of even a small percentage of benzine will affect the safety of kerosene, we give below the results of the experiments of Dr. D. B. White, of the New Orleans Board of Health, upon an oil which flashed (gave off an explosive vapor) at 113° Fahr.—13° above the limit of safety fixed by the usual laws on the subject. He found that the adulteration of

1	per cent.	of benzine	caused it	to flash at	103° F.
2	"	"	"	"	92°
5	"	"	"	"	83°
10	"	"	"	"	59°
20	"	"	"	"	40°

and that after the addition of 20 per cent. the oil *burned* at 50°—considerably below our average summer temperature, or the temperature of our houses in winter.

Prof. Chandler has given the following estimate of the profit accruing to the refiner from the adulteration of the kerosene: "On every gallon of naphtha run into the kerosene tank there is a profit to the refiner of twenty cents, or on every per cent. of naphtha added to the kerosene a reduction of one-fifth of a cent per gallon in the cost of production, which, with kerosene at 25 cents per gallon, amounts to 1¼ per cent. For every gallon of naphtha sold as kerosene, the refiner can afford to throw away four gallons."

It will, therefore, be understood how highly desirable it would be if some discovery should be made by which the demand for naphtha for industrial purposes would be so largely increased as to raise its price above that of kerosene, and thus withdraw it from its present reprehensible use as an adulterant of kerosene, by taking from the refiner and vendor of burning oil the temptation to so use it. From what we know of the subject, we fear that it will only be when the interest of the refiner or vendor is at stake that adulteration of kerosene will cease; and this state of affairs will only be brought about when benzine is worth more than kerosene. Whether or not the several petroleum-gas processes now growing into popularity will in time furnish us a way out of the difficulty, time alone will show.

It is a mortifying commentary upon our want of success in enforcing laws made in the interest of public safety, that only the *safe products* of petroleum are exported from this country to Europe, and that all others are carefully excluded by a faithful system of inspection at the ports of entry; a proof that it is not the fault of our laws on this subject, but of those whose duty it is to see that they are enforced. W.

THE BEAUMONT COMBINED HEATER, FEEDER, AND CONDENSING PUMP.

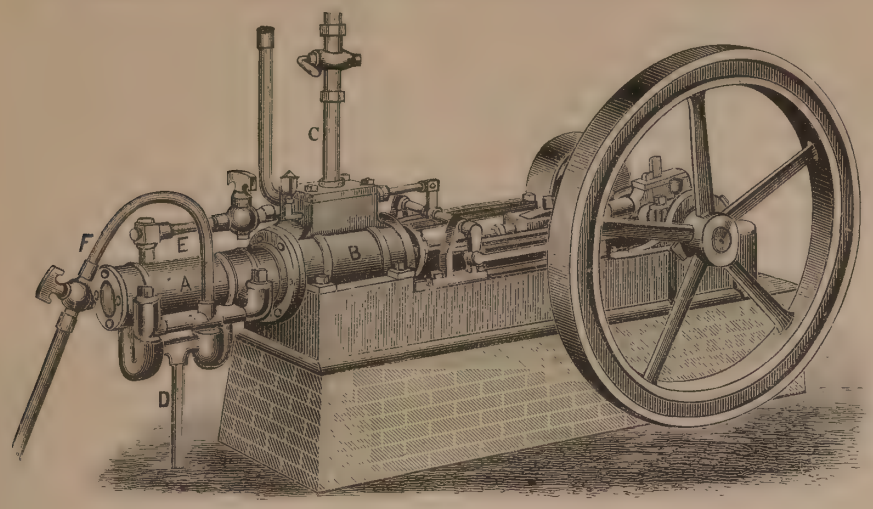


Fig. 1.

The economy resulting from the heating of feed-water is an item which figures so conspicuously in the savings which the advance of science and of inventive genius has made possible in the use of the steam engine, that every new invention which promises either greater efficiency, more ready applicability, or even less cost at first purchase than any existing device, is always welcome and worthy of an unprejudiced examination.

The accompanying cuts illustrate the Beaumont combined Heater, Feeder and Condensing Pump.* Fig. 2 represents a single acting plunger pump which serves both as a heater and feeder. It is the cylinder of a pump of ordinary size in which the plunger *B* acts. *C* is the inlet pipe for the exhaust steam; while *D* is that of the condensing water which impinges in the form of a jet on the exhaust steam as it enters the pump chamber, condenses the same and is thereby heated, and is then forced by the descent of the plunger into the boiler through the pipe *E*. *F*, *G* and *H* are respectively the check valves situated in the feed pipe, the water inlet, and the exhaust steam pipe. *I* is a cock through which such sediment as may collect in the cylinder can be blown out.

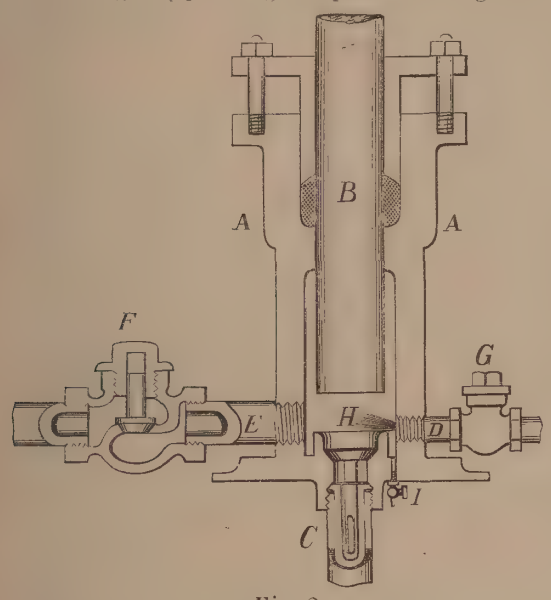


Fig. 2.

The double acting pump represented in Fig. 1, is attached immediately to the cylinder head, and the plunger of the former is merely a continuation of the piston rod of the engine.

The pump cylinder *A* has an internal area equal to about $\frac{5}{12}$ that of the engine cylinder *B*.

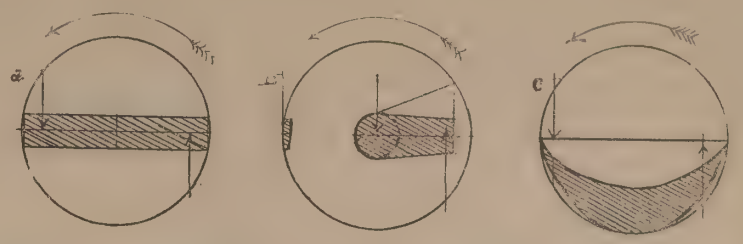
E is the exhaust pipe of the engine which admits the steam to the pump; this pipe is attached to the exhaust pipe proper by means of an elbow. *F* is intended to represent, in a very awkward way, the pipe which is to conduct the condensing water to the pump. Since the pump is double acting, the water is, by means of a *T* piece, admitted alternately at either end of the pump cylinder and immediately opposite the entering jet of exhaust steam. *D* is the outlet pipe through which the feed water is forced. It is apparent that the taking away of the exhaust steam as soon as released in the cylinder totally prevents back pressure, and by the formation of a vacuum considerably augments the power of the engine.

It is claimed that by means of these pumps the feed water can be heated to 200° F. by utilizing but from 7 to 10 per cent. of the exhaust steam, and this without causing a diminution of the draft; for if we assume that the economy resulting from the use of pump to be from 15 to 20 per cent., at the expense of from 7 to 10 per cent. of draft, it is apparent that the result is the same as if the draft had artificially increased by from 8 to 10 per cent.

O. C. W.

THE PHILOSOPHY OF DRILLS.

Drills for wood generally have two sides different; those for metal almost invariably have two similar cutting edges, being in this respect more perfect tools. The cut shows three drills; the direction of rotation being shown by the arrows. At *c* is a spoon-bit for wood; *b*, a centre-bit for wood; *a*, a flat drill for metal. In each case the circle shows the hole bored. It will be seen that the drill *c* has acting upon it two equal and opposite forces; one tending to force the cutting edge into the wood, and the other to press the rounded back against the side of the hole, causing heat and loss of power. From this cause, spoon-bits are notoriously hard to drive and heat quickly, especially in hard woods. In *b*, one force operates to drive the cutting edge into the wood, while the other, instead of crowding a wide surface against the side of the hole, is partly used in driving the "nicker," and partly wasted in creating a side strain upon the centre pin. In the drill *a*, however, both these equal and opposite forces are wholly utilized in cutting, and there is no tendency to make a non-circular or a curved or slanting hole. The double spiral screw auger is a wood-borer that is symmetrical. There is a one-sided on non-symmetrical metal-drill used by Swiss watch-makers; but as it is driven in both directions alternately, it cuts straight and true, although there is power wasted by friction at every turn in either direction. The great superiority of



the twist drill for metals is largely owing to its being symmetrical, and hence, wasting no power, and cutting straight and true; those drills, the body of which is not of the full diameter of the hole, being harder to guide, while possessing also the disadvantage that each sharpening reduces the size of hole they cut. The twist-drill is not as strong as the straight-fluted drill, but (with a proper point) requires less feed-pressure. If its point were formed conical, no available pressure would feed it to its work. The greater the angle between the cutting face of the drill and the surface of the work, the less feed is required, or the "more greedy" the drill becomes.

G.

SHRINKAGE OF IRON CASTINGS.

The chief trouble with iron castings is their liability to have internal strains put upon them in cooling, in consequence of their shrinking. The amount of this shrinkage varies with the quality of the metal and with the size of the casting and its comparative thickness. Thus locomotive cylinders shrink only about $\frac{1}{16}$″ per foot, ($\frac{1}{192}$=.0052), while heavy pipe castings and girders shrink $\frac{1}{10}$″ per foot, ($\frac{1}{120}$=.083), or even $\frac{1}{8}$″ per foot, ($\frac{1}{96}$=.0104.) While small wheels shrink only $\frac{1}{25}$″ per foot, ($\frac{1}{300}$=.0033), large and heavy ones contract $\frac{1}{10}$″ per foot, ($\frac{1}{120}$=.0083.)* Now, if thick metal, proportionately, shrinks more than thin, we must expect any casting not absolutely symmetrical in every direction to change its form or proportion,† and in many cases we will find them strained and twisted. Those parts which cool first get their final proportions, and the later cooling portions strain the earlier, the resistance of which to deformation puts strains on those cooling. This initial strain may, of itself, break the casting, and if not will weaken it. Castings of excessive or varying thickness, and of complicated form are most in danger from internal strain. This strain is gradually lessened in time by the molecules "giving." In a casting such as *A*, (Fig. 1), in the figure—say a thick press

Fig. 1. *Fig.* 2. *Fig.* 3.

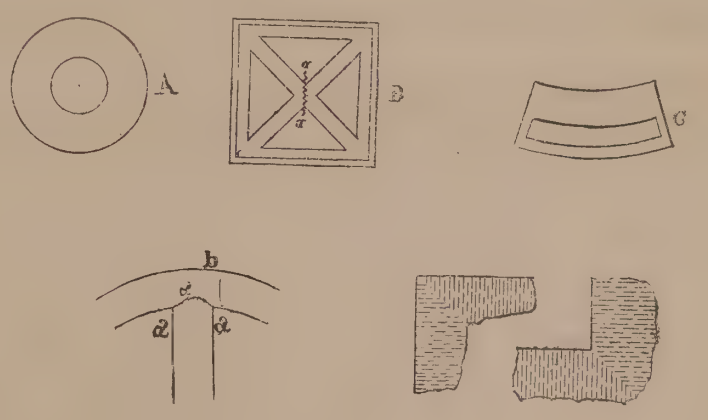


Fig. 4. *Fig.* 5

cylinder, the outer layers solidify and shrink first, and as the inner layers contract after the outer ones have "set," causes a compression of the outer layers and a tension of the inner. Such a cylinder will, if subjected to internal pressure, be weak, because there is already in the inner layers a force tending to expand them. The cylinder would be stronger if these layers were braced to resist extension, or in other words, were already in compression. If we cool the interior first, by artificial means, while delaying the cooling of the exterior layers, we have these layers braced to receive gradual or sudden pressure, and this is especially desirable in cannon.‡ In a panel like *B*, Fig. 2, with a thin but rigid flange, the diagonals shrink more slowly than the rim, and a crack through *a a* is likely to appear. A casting like that at *C* would solidify on the thin side first, and when the thick side shrank it would curve the bar and compress the thick part, and put the thin in tension. Wheel and pulley castings are especially troublesome. The latter have a thin, rigid rim, which cools before the arms, and when the latter cool they are very apt to break by tension along the line *a a a* (Fig. 4). If the arms set first they are apt to break the rim as at *a b*, as they make a rigid abutment, which resists the rim-contraction, bending the rim and breaking it from within outwards.

The cooling of castings has already been alluded to, with particular reference to the arrangement of the particles; and we will here simply note that the particles range themselves in crystals perpendicular to the cooling surface, and that hence we may expect to find weak points at sharp corners, as in Fig. 5. The remedy for this is to round off all angles.

G.

*Patented by A. de Beaumont, 215 Race St., Philadelphia.

*The "shrink-rule" is employed by pattern-makers to relieve them of the labor of calculating these excesses of .00520.083, etc., the scales being graduated to inches, &c., which are 0052, .0083, etc., too long.

†A cubic or spheric mould yields a cube or a sphere as a casting; but a mould say of the proportions of 100×5×1, shrinking differently according to dimensions, gives a casting not only less in size but in somewhat different proportion.

‡See article on "Cooling of Castings," POLYTECHNIC REVIEW, vol. iv, page 43, date of July 28th, 1877.

ON THE CULTURE OF THE SUGAR BEET.*

By G. Barbier.

Plowing up the Stubble.

Immediately after harvest the ground which is to produce sugar-beets the following year should be passed over by the gang-plow in both directions, lengthwise and crosswise, in order to give it a thorough mixing and uproot the weeds. After this operation, when the weather and the condition of the soil permit, the ground should be well harrowed and rolled, in order to make the parasitical plants germinate and come up, the seeds of which have remained in the ground and which are subsequently exterminated by winter tilth.

Manuring.

After rolling, and upon the heaviest soil first, as the lighter portions are to be plowed last, about 20 tons per acre of such farm-yard manure as is available should be spread. The liquid manure should be spread upon the lighter and sandy portions of the soil whenever the weather is favorable, and as early in September as possible. It is best to wait until the soil is dry before spreading liquid manure.

The farm-yard manure should be allowed to dry during a few days after it has been spread, if the weather permits, as this insures a more complete decomposition, and land which is thus treated becomes more fertile and mellow after plowing than would otherwise be the case.

Plowing.

When the manure which has been spread becomes sufficiently dry, the plowing may be commenced. It is best to begin with the moist and heavy portions of the soil. The object of this plowing is to bury the manure, and it should be as deep as possible, although it is unnecessary to reach a depth of more than a foot.

In case, in the beginning, the cross-plowing with the gang-plow is intended to be omitted, the manure should be spread on the stubble immediately after harvest; and after allowing it to dry, as has been explained, a very shallow plowing should be given to the land, in order to bury the manure slightly, after which a very deep plowing must be performed in order to place the manure in the middle of the available layer of soil.

It is very important that the heavier portions of the soil should be plowed before severe frosts make their appearance; for it is a noteworthy fact that when soil is worked in this manner it becomes quite mellow, and it has been observed that when two portions of the same kind of soil are plowed, the one before and the other after winter frosts, the former yields a much better crop than the latter.

As a rule, it is well to avoid plowing when the ground is wet, and it should be laid down as a principle, never to work land when it is in a condition to pack; this applies obviously to treading upon it and transporting objects over it. When wet ground is packed it becomes exceedingly hard, and cracks open upon drying; it does not get warm under the influence of the sun, and the manure remains undecomposed in it.

As has already been remarked, the lighter portions of the soil are to be plowed last, and with them this operation is often deferred until Spring, and with good results when the ground is in a proper condition. The dryer they are when they are plowed, the fresher they will be during the Summer. This manner of proceeding makes it possible, too, to utilize the manure as it is gradually produced upon the farm.

The Use of Chemical Fertilizers.

Upon the ground which has been prepared according to one or the other of the preceding methods, and two or three weeks before sowing time, the chemical fertilizers, or cakes forming the supplement of the manure, should be placed in the soil. Such fertilizers may be composed of 500 lbs. of rape-cake, mixed with from 200 to 300 lbs. of superphosphate of lime, per acre; or, if it is preferred, double the amount of rape-cake alone may be allowed to the acre. The rape-cake employed thus without the superphosphate of lime makes a very good supplementary fertilizer. These fertilizers, especially the rape-cake, should be well pulverized, and may be spread either by hand or with a drill; in the former case they most be turned under by the harrow or by the gang-plow. By this means the fertilizers are mixed with the soil, and produce, by their decomposition, a warmth which serves to aid the germination of the seed which is subsequently placed in the soil. If, on the other hand, these fertilizers are placed in the soil at the time when the seed is sown, the latter is placed in immediate contact with chemicals which are undergoing decomposition, and a part of the seed is apt to be destroyed and the yield impaired by the burning of the seed, caused by the rapid fermentation which the decomposition of the fertilizers occasions.

Rolling.

Before sowing the beets, and as early as the weather permits, a good rolling should be given to the soil. This compresses the soil, leaving it less exposed to the air, so that it drys less rapidly, and is in a better condition to receive the seed, the sowing of which is next in order. After the seed is deposited, the ground should receive a second rolling, in order to press the earth more closely around the seed, and place it in a condition more favorable to germination than would be the case if the seed were not in immediate contact with the soil. These rollings should never be undertaken when the ground is not sufficiently dry: for it is fatal to pack the seed up in a mass of wet earth, which not only keeps the air and the warmth of the sun from the fertilizers as well as from the seed, thus retarding germination, but which also becomes so hard upon drying that the germ, if it develops at all, is obliged to seek an exit by shooting out in different directions, only to meet with an impenetrable crust, and finally perish.

Sowing.

The seed should be placed in the ground as soon as the hard frosts are no longer to be feared, and when the soil has become sufficiently dry. The sooner the seed is sown the better, for the beets should remain as long as possible in the ground, in order to make the final yield as abundant as possible. The rows of beets should be placed about 16 inches, never more than 20 inches, apart. In the rows, the beets should be kept as nearly as possible at a distance of 10 inches from each other. The seeds should be covered with a thin layer of earth, and from 7 to 9 lbs. of seed to the acre is a good allowance. By sowing thus plentifully, an abundant crop of plants is insured, so that the crop is better adapted to withstand the ravages of insects, as the plants are produced in superabundance. By using a sufficiently large amount of seed, the crop may be forwarded a couple of weeks, thereby advancing the first cultivation, which has an immense influence on the weight of beets produced upon the acre.

First Cultivation.

As soon as the plants have so far made their appearance that the rows can be discerned, a first cultivation should be immediately begun. This may be done with the horse-cultivator. The result of this operation is a thorough stirring-up of the soil, which permits it to receive warmth from the first rays of the sun, so that the decomposition of the manure is further accelerated. Then, too, the fermentation brought about by this decomposition kills the insects or drives them away from the plants.

Spacing.

As soon as the first cultivation is terminated, the plants, which are quite thick in the rows, these being about 18 inches apart, must be placed at proper distances from each other in the rows. To this end the rows may be passed over crosswise by the shovel-plow, so as to leave tufts of plants 8 or 10 inches from each other.

Culling.

Immediately after spacing, the culling should be commenced. This operation consists in pulling up all but the best one of the plants in each tuft or hill. The plant which is to remain should be held protected in one hand while the other pulls up the surrounding roots. The culling ought to be begun as soon as the plants have two leaves. At this moment they are still quite weak, but the operation must be performed as early as possible, in order that the plants which are to remain may obtain the full benefit of the fertilizing agents in the soil. In this way they soon gain the strength which is necessary to adapt them to withstand late frosts and future droughts, and the greatest possible yield of beets is thus most likely to be insured.

Second and Third Cultivation.

A second cultivation should be begun as soon as the superfluous plants have been pulled up. Between the rows the horse cultivator may be used, as in the first cultivation; while, in addition, the shovel-plow should be passed between the hills in the other direction.

The third cultivation is to be performed as the weeds make their appearance; it should be done with great care not to break the leaves of the plants, which would injure the proper development of the beets. Sometimes, when the season is wet, an unusual growth of weeds renders it advisable to give the beets a fourth cultivation, which should also be very carefully executed.

Harvesting.

The beets should be harvested as soon as they become ripe; that is, when their leaves become yellow and droop. In digging up the beets the use of the fork and like instruments should be avoided, as these are too apt to mutilate the roots. There is a kind of plow, made specially for the purpose of uprooting beets, which is far superior to anything else. The beet plow has neither colter nor mould-board, and it raises the beets without injuring them, leaving them in a row on one side of its track, half buried in the loose earth, from which they can easily be gathered. After being thus uprooted, the beets should be cleaned, their leaves removed, and the roots piled up in heaps, which should be covered with leaves and remain so until they are drawn in. This preserves them from the action of the sun's rays, which would diminish their weight and render them less likely to keep well. The covering of leaves also protects the beets from being bitten by early frosts, and cannot be too strongly recommended.

The Yield.

In France an acre of ground yields an average amount of 20 tons of beets; in Germany, Holland and Belgium, about 25 tons, while in Austria the average yield is often still greater.

Success in beet-culture depends far more upon the attention given to the preparation and tillage of the soil than any advantage which may be expected from the most favorable atmospheric influences. Beets have been found to withstand heavy rains, late frosts and even the most protracted droughts, by being placed in a soil which has received a thorough preparation; and whatever may be the disturbances in the climate, &c., a fair yield may always be expected when the directions which have here been given are rigorously followed.

*Supplementary to article on Root Beet Sugar, page 111 of current volume.

UTILIZATION OF WASTES.

Although within a few years many of the waste products of manufactures formerly thrown away have been made to serve a useful purpose, there is yet room for effort in this direction, and the reward is certain. The manufacturer who discovers a heretofore unknown use for the waste product of his work, necessarily cheapens the cost of the principle article of his production, and thus secures an advantage over competitors. Much has already been done in this direction. Nickel and cobalt have been obtained profitably from refuse ore which was formerly thrown away. The refuse liquor of soap manufactories has been made to yield up its glycerine. Soda "waste" gives sulphur and hyposulphite of soda. Furnace slag makes building and paving materials. The trimmings of animal hides yield glue. The waste of gas factories produces the unsurpassed aniline dyes. Even leather scraps have been re-converted into a material of use. But there are other waste products which, it would seem, could be made, under the direction of that mighty converter, Chemistry, to yield substances of use and profit.

A very successful attempt has recently been made in Worcester, Massachusetts, to convert to use the waste of the well-known wire-works of the Washburn and Moen Company. Formerly the dilute sulphuric acid used to clean the wire was allowed to run into the sewer, when it had become so charged with the iron scale as to cease to "bite," and large quantities of refuse wire were employed only to fill up hollows in grading or thrown into a heap. All this waste material is now, however, converted into articles of commercial value by a company known as the Pillar Copperas Works, in Worcester. The processes are simple and comparatively inexpensive. The diluted acid, charged with iron, is heated in lead-lined tanks by means of steam passing through coils of copper pipe, the waste wire being thrown in. In about five days the acid, under the influence of heat, has taken up a large proportion of iron and become liquid sulphate of iron, which is then evaporated until it readily deposits the well-known crystals known in commerce as copperas. Three tons of this solid sulphate are made per day from about twelve tons of the waste acid. The remaining liquid is returned to the receiving tank to be mixed with more of the waste acid and refuse wire, and so the work goes on in a continuous round. Even the waste of this product from waste is utilized. The settlings of the boiling tank—oxide of iron—together with the waste copperas, an alkali, and an inexpensive substance to give "body" are roasted, ground, and metamorphosed into a pigment quite equal to imported Venetian red. Of this the company makes about five hundred barrels per onth. J. H. L.

IMPROVEMENT IN SCREW CUTTING TOOLS.*

Most bolt threading is far from being "screw cutting," the thread being either jammed up, or impressed, or rubbed out. An improvement, (patented by E. P. Baville and A. Greenwood, of Leeds, England, and the illustration of which we copy from the *English Mechanic*, xxiv, 602) consists in substituting for a segment-shaped cutting die, a cross-section of a steel cylindrical screw tap or threaded plug, channelling it so as to form four distinct cutters, each possessing two cutting edges.

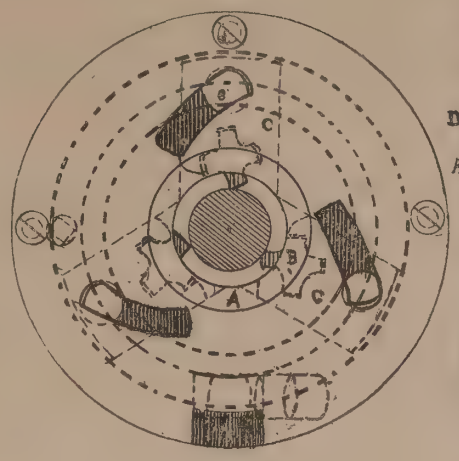


Fig. 1.

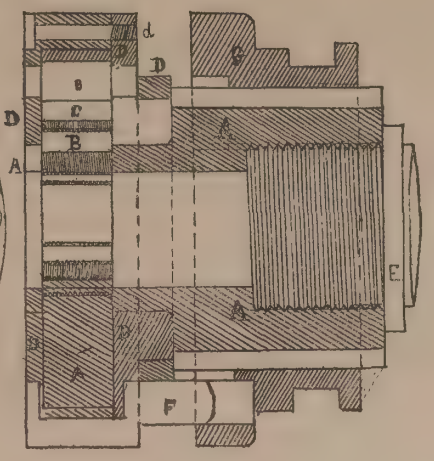


Fig. 2.

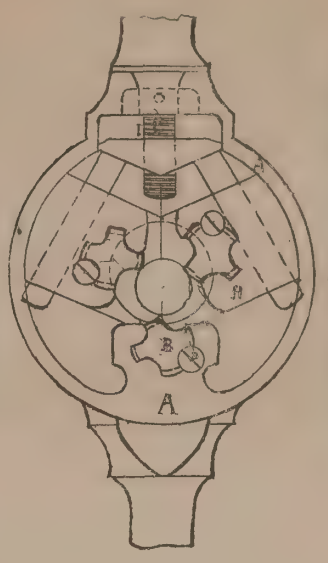


Fig. 3.

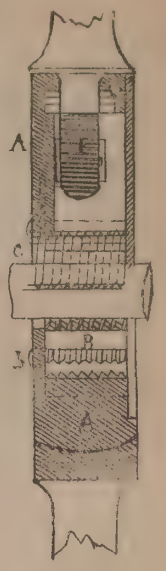


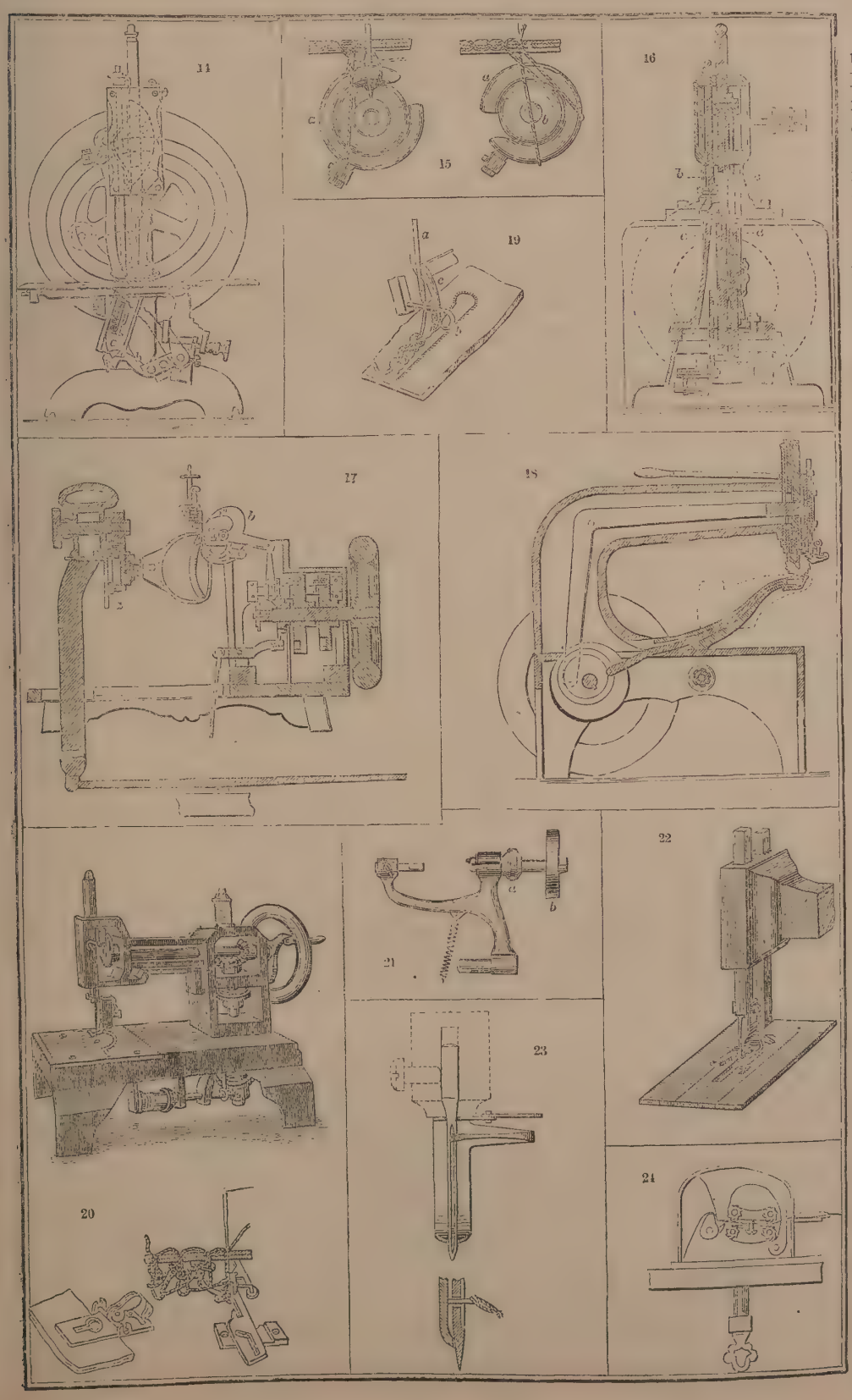
Fig. 4.

In Figs. 3 and 4, *A* is the screw-stock carrying the cutters *B*, and having suitable handles. The breadth of the cutters *B* is shown equal to the stock; this while not necessary, is preferable, as insuring more steady working. Each tool is fitted into a slot or recess, made transversely of the stock and having the counterpart shape of the cutter. This recess is so situated that one cutter of the four will project into the central space, holding the work, at a favorable cutting angle, as in a lathe. A transverse pin, *b* holds the cutter in the stock. It is evident that any one of the eight cutting edges of the tool may be presented.

Where only one cutter is used, the work is pressed up to it by a threaded semicircular rest sliding in guides in the stock, and dovetailed to a threaded socket, bearing a screw *E*, made fast to or forming part of one of the handles, which is fitted loosely to the stock *A*, so as to turn freely, and thereby advance or withdraw the sliding rest. It if preferred to use 3 cutters (this arrangement being shown in side view in Fig. 3, and in cross-section in Fig. 4.); two of these tools *B* are fitted into slots formed in radial sliding plates *H*: the third being in a recess in the stock *A*, screw *E* forces down a cross-head, which bears the movable cutters to their work.

Figs. 1 and 2 show the device mounted for use on a lathe; a stop pin determining the diameter of the screw to be cut.

*See article on thirteen different ways of screwing, the POLYTECHNIC REVIEW, vol. iv, 14.



THE PRINCIPLES OF ACTION OF SEWING MACHINES.—II.

Supplementarily to what we published in our last issue, we give herewith the illustration and description of Plate LXI of Knight's Dictionary, in which Fig. 14 completes the series of lock-stitch machines already described. In this machine the shuttle *a* is stationary, and the loop of the needle-thread is passed over it by a vibrating arm *b*.

Fig. 15 is typical of the class of machines which make a lock-stitch by means of revolving hooks. The rotating looper *a* enters the loop of the needle-thread and carries it around a loose disk-bobbin *b* on the face of the hook. Wheeler & Wilson pattern.

The leather sewing machines are represented by Fig. 16, in which a hook-needle *a* below the cloth takes thread from a carrier *b* above the cloth, draws down the thread and enchains it below. An awl *c* perforates the leather for the passage of the needle; a cast-off *d* discharges the loop.

Figs. 17 and 18 are sole sewing machines. In the former the shoe and last are carried on a jack *a*. A chain-stitch is formed by a hooked needle, which passes through the sole and upper, and takes its thread from a carrier. The awl *b* perforates the material for the passage of the needle. In Fig. 18 the shoe is supported on a horn provided with a thread-carrier. A hooked needle passes through the sole and upper and takes the thread from the carrier and forms the chain portion of the stitch in a channel cut in the outer face of the sole. A cast-off works in connection with the needle.

Not the least important and ingenious are the button-hole machines represented by Figs. 19 and 20, respectively a single and double thread machine. For the latter a hole is cut in the goods for the button-hole; the material is held in a clamp, which is moved under the needle, so that the leather makes a circuit of the button-hole a short distance from the edge. The needle descends alternately through the material back from the edge and then ever the edge; the loop formed by the first descent is interlocked by the loop formed by the second descent, and this second loop is secured by a looper-thread.

The remaining figures represent miscellaneous parts belonging to different machines; thus Fig. 21 is a winder for shuttle-bobbins, which are held between the two heads and rotated by the contact of the friction wheel *a* with some rotating portion of the machine; *b* is an emery-wheel for sharpening needles.

Fig. 22 shows a knife attached to the needle-bar to cut material parallel to the seam; Fig. 23 is a needle-setter and threader; and Fig. 24 represents a piece of mechanism by means of which the material to be sewed is drawn on to the point of the needle and off of the machine after being stitched.

"LAP" *vs.* "BUTT" RIVETED JOINTS.

Fig. 1.

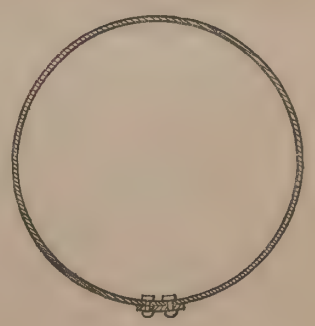


Fig. 2.

On account of the departure from circularity which it occasions, the lap-joint shown in Fig. 1 is weaker than the "butt" and cover-joint in Fig. 2. The only figures we have on the subject are by Fairbairn. Two tubes, each 9″ diameter, 37″ long, 14″ thick, one made as in Fig. 1, the other as in Fig. 2, collapsed at 262 and 378 pounds per square inch, respectively; the collapsing pressures reduced to unity of length and diameter being respectively 7270 and 10489.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

SECOND PART, V.—IRREGULARITIES AND THEIR RECTIFICATION.

The results of the foregoing considerations will be somewhat modified when we take into account the complicating elements of the link and crank motion.

The effect of the angularity of the connecting rod has been considered before.

The irregularties arising from the oscillations of the eccentric rods can be met corrected in degree by adjusting the valve to have equal lead at the fore and return stroke.

The oscillation of the link has the effect of drawing the ends of of the eccentric rods nearer the centre line, and since this (by reason of the inclined position of the eccentric rods) is accompanied by a horizontal movement from the crank-shaft, this influence is equivalent to a temporary lengthening of the eccentric rods while the link is inclined.

Another source of variation from our theoretical results is the "slip." Owing to both the mode of suspension and the oscillation of the link, the latter is caused to slip up and down on the block, and the valve is not operated from a fixed point of the link. The slip depends mainly on the mode of suspension and, as a general rule, has likewise an effect equivalent to a temporary lengthening of the eccentric rods as the link assumes an inclined position. The slip can be reduced by lengthening the link and suspending it as shown in Fig. 36 or 37.

There are still other influences of a similar character, but being of minor importance their special mention is here omitted.

It will be remembered that the cutting off on both ends of the cylinder can be rectified by lengthening the eccentric rod, but that this proceeding will render the lead unequal for both strokes. Hence, if we could temporarily lengthen the eccentric rods for the time of the cutting-off and restore their original length for the beginning of each stroke, the cutting-off could be equalized without destroying the equality of the lead. Now, we have seen that the link-motion possesses a feature of this description, and by a judicious choice of certain dimensions we may correct one irregularity by the other. This correction, it will be seen hereafter, is accompanied by an increase of the slip, and we have to choose one of two evils: increased slip, which is attended with greater wear on the link-block, or unequal cut-off, which is attended with a less uniform motion. The former is preferred by most practical engineers.

We may consider the subject of rectification in a somewhat different light. It is known that the cylinder takes more steam on the fore-stroke than it does on the return-stroke, if no rectification is attempted. Remembering, now, that with the link-motion we have it the power to change at pleasure the degree of expansion, it is easily seen that a rai-ing of the link on the fore stroke and a lowering on the return-stroke does precisely what we want. There are two means at our disposal that will accomplish this automatically. We may shift the suspension pin of the link, laterally, towards the inside or outside of the link, as the case may require, and employ the "oscillating movement" of the link for the purpose; or we may place the hanger in an inclined position, turning the "reciprocating movement" to our use.

Attention should, however, be paid to one circumstance. If the link is suspended in its centre, there are two grades (one forward and one backward grade) at which the suspension pin of the link, as the valve is cutting-off at the return-stroke, will have returned to the same position it occupied at the same period of the fore-stroke, and which we may call, for future reference, the "reciprocal grades." At these grades the cutting-off is effected the moment the imaginary eccentric i^0 (Fig. 47)

Fig 47.

of the movement of the suspension pin D is at right angles to its imaginary line of operation, OD. The inclination of the hanger can, therefore, not produce the required lowering or raising of the link at either stroke, and we can employ only the oscillating movement of the link for correction.

Since we are restricted to guide the upper end of the hanger in a circular arc, the radius of which is limited to a certain degree, we cannot, after correcting the reciprocal grades, accomplish the perfect rectification of any more than two additional grades, and it is best to choose the full stroke grades for this purpose. The other intermediate grades will then be found so nearly rectified that there will be no need for any further improvement.

The number of grades for which a correction is possible, when the link is suspended on its lower end, is likewise limited to four, and in order to bestow the rectification upon advantageously distributed grades, a careful lateral location of the suspension pin is necessary. If a choice in this respect is excluded, for instance, if one of the pins of the eccentric rods is used for suspension, we must be contented with a less perfect rectification, or as the case may be by bestowing a perfect rectification upon the forward grades only.

The selection of the grades for perfect rectification of the cut-off must be left to the judgment of the designer; it is, however, not necessary to take any of those grades for which the arc of the reversing-lever is notched, as any other intermediate grade is equally serviceable. As a rule, the full stroke grades, and those for cutting-off at half stroke, for both forward and backward rotation, are a fair base for correction, and they have been chosen in the following practical examples.

After these preliminary remarks we may take up the discussion of the way for finding the proper dimension of the suspension mechanism.

The complication and variety of the disturbing influences render it almost impossible to bring them fully to account without the construction of an actual model, or an equivalent thereof. Such a model can be prepared of stiff drawing-paper or thin wood, and attached, by thumb tacks, to the drawing-sheet on which the suspension lever is to be laid out. It should always be made to full size to insure sufficient precision.

The principal dimensions of the hanger, the link, the eccentric rods, the eccentrics, etc., should be determined to suit the special case, and, as shown in the two problems, the first of which shall be used for exemplification, supposing the connecting rod to be equal 5 cranks, and the hanger $=16''$.

The link may be made as shown in Fig. 48 or 49, and should

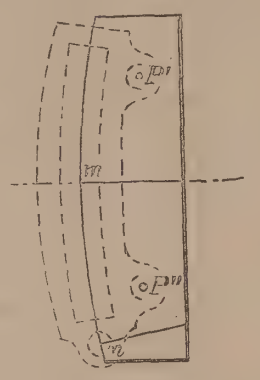

Fig 48.

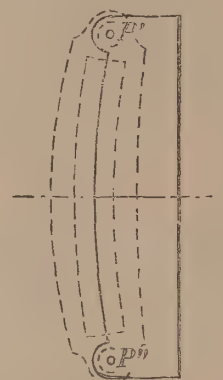

Fig. 49.

be cut carefully along the centre-line of the slot. The eccentric rods may be made of two strips of paper and provided with two pin-holes at their ends, at the exact length of the contemplated eccentric rods, and they should be marked "foward" and "backward," or "+" and "—", for contradistinction.

We now draw the centre line of the link-motion (Fig. 50) and

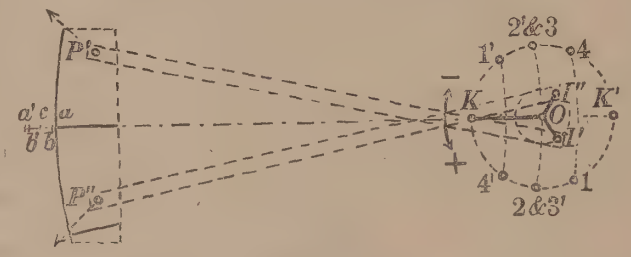

Fig. 50.

sweep from O the orbit Z of eccentrics. Then we construct crank-angles, the cutting-off of the four grades that we selected for the base of correction (which are $\frac{4}{5}$ and $\frac{1}{2}$ of the stroke) by the proper circular projection.,

In Fig. 50 these crank-angles are marked 1, 2. 3, 4, and 1′, 2′, 3′, 4′, the former standing for the fore-strokes and the latter for the return-strokes.

The link can now be attached to suit any crank-angle by finding, by means of the angles of advance, the corresponding positions of the two eccentrics, and pinning the eccentric rods to those points, care being taken not to pin the "forward rod" to the "backward eccentric." The free ends of the rods may be fastened to the link by thumb tacks, with their points up.

The mode of procedure is now as follows: Attach the link to the first dead centre of the crank K, as shown in Fig. 50 by dotted lines, pull slightly in the direction of the darts, to stretch the paper straight, set the link to mid-gear, and mark with a sharply pointed pencil the point a. Repeat this operation for the second dead centre of the crank K' and obtain the point a'. Bisect the distance $a\,a'$ in c and regard this point the centre of movement of the link-block. In this way we secure an equal lead as regards fore and return stroke at the mid-gear. If the link-block is attached to a rocker, let the arc of the movement of the block pass through the points a' and a''. Then mark the positions of the block, b and b', at which the valve will just close the ports by making $cb=cb'$ equal to the outside lap of the valve (duly reduced, of course, when a rocker of an equal leverage is interposed).

Now, suppose the link was to be suspended at its lower end, somewhere in the line n (Figs. 48 and 50). Attach the link successively to all the crank-angles marked before, adjust its curved edge to b or b', accordingly as the crank-angle pertains to the fore or the return stroke, and mark the position of the line n of the link and its termination (or intersection with the link-curve) on the drawing. We thus obtain the eight lines shown in Fig. 51, where they are marked as the corresponding crank-angles.

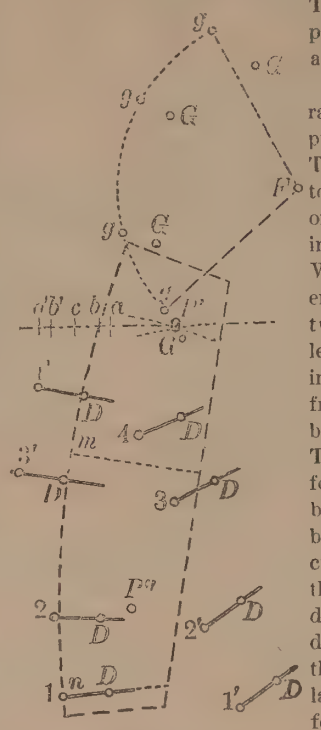

Fig. 51.

They represent, as it were, the positions the link will occupy at the respective periods.

We have now to find the lateral location of the suspension pin on the line n of the link. To this end we first suppose it to be located in the centre-line of the slot, or, in other words, in the termination of the line n. We sweep accordingly from the end points of the lines 1 and 1′ two arcs of a radius of 16″ (the length of the hanger). Their intersection gives the point G^0 from which the hanger should be suspended for the first grade. The points of suspension, $G\,G$, for the three other grades can be found in the same manner, but it will be seen that no one circle can be drawn through these four points, hence they do not satisfy the required conditions. However, if we move the suspension pin of the link laterally, we can find, after a few attempts, a point, marked D on every one of the lines of Fig. 51 that furnishes points of suspension, g, g, which can be connected by a circular arc. The centre, F, of this arc determines the location of the fulcrum, and its radius the length of the required suspension lever. The point D can now easily be transferred to the link, and the designer can accordingly finish the detail drawings

The above course of procedure will have to suffer a slight modification if the link is to be suspended in its centre-line m (Fig. 48). The eight different locations of the link must be marked by the centre line m, and will appear as shown in Fig. 52. It will be observed that the lines 2 and 2′, as well as 3 and 3′, intersect in a point from which the end points of these lines are nearly equidistant, simply because the grades 2 and 3 are in close proximity to the reciprocal grades. By rights we ought to have taken those latter grades instead of 2 and 3, but we obtain practically the same result by averaging the distances of the said points of intersection from the termination of the respective lines and take this distance for the lateral position of the suspension pin D, which then can be located on the eight link-lines. Next we determine the points of suspension, G' and G'', for the grades 1 and 4, and mark through these points the arc of the suspension lever. The latter should be made as long as convenient, in order to have the intermediate grades more nearly corrected.

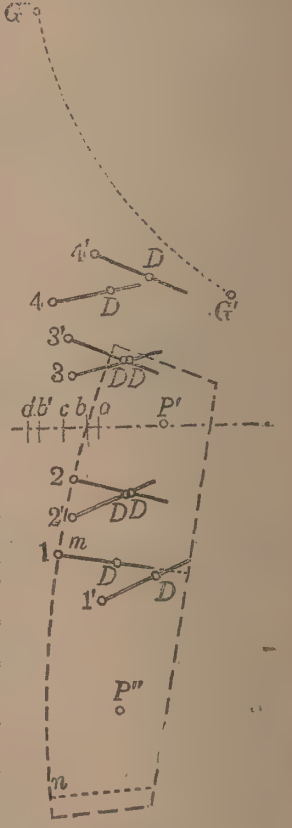

Fig. 52.

When a link motion is rectified in this manner as regards the cutting-off, it will be found to be nearly so for the cushioning and the release. One of the agencies employed for the rectification, namely, the inclination of the hanger, will slightly effect the lead, especially at the full-stroke grades, but the difference is so small that it can hardly be noticed. The port-opening, indicated for any crank-angle by the diagram, will also slightly deviate from the actual port-opening of the link-motion, and will generally differ at the corresponding periods of both strokes The greatest port-opening may thus become smaller than premised

It must not be overlooked that the rectification is accomplished at the expense of the slip, and it is therefore necessary to sufficiently lengthen the slot of the link for this purpose. The paper model affords the means for finding the extent of this lengthening.

The slip may sometimes become excessive, and it may then be expedient to abandon the perfect correction and compromise between this correction and the slip, by suspending the hanger more nearly in a vertical line than demanded by the above rule. Or the valve can be made with unequal lap for both ports, correcting the cut-off at the expense of an equal lead.

The described manner of attaching the eccentric rods and the link by thumb tacks may involve some inaccuracy. Greater precision may be attained by drawing the link on tracing-paper, and instead of using the paper eccentric rods, sweeping arcs from the respective positions of the eccentrics, and by adjusting the pin-centres of the link to those arcs, the position of the link can be obtained as before.*

(To be continued.)

* This latter method for finding the position of the link for any given crank-angle has been used in England. Auchincloss, in his treatise on "Link-motion," recommends the use of a template cut of thin wood, to be adjusted to those arcs.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Influence of Light on the Electric Condition of Metals in Saline Solutions.—Metal plates were placed by Herr Hankel, one in a porous battery cup (closed by a cork) the other in a transparent exterior vessel. The vases were filled with solutions and enclosed in a blackened box in which was an aperture which could be closed at will, or before which colored screens could be placed.

With two plates of polished copper, plunged in water, the plate on which the sunlight fell was negative. The action of colored rays reached its maximum in the blue. When the copper became more or less strongly oxidized or covered with salts, the plate, at first positive, then became negative and kept its sign when the light was altogether suppressed. The action is ascribed principally to the feebly refrangible rays, while the dark blue or violet rays render the plate negative. Polished copper in sulphate of copper became first negative and then strongly positive.

Other metals gave the following results: Clean plate of polished silver, in water, negative; lightly silvered platinum, positive; silver covered with platinum, strongly positive; tin, negative; brass acted like oxidized copper; amalgamated zinc, in solution of $zno.so_3$, strongly negative; ordinary zinc, nearly neutral (hence the action of the battery is due to the oxidized copper); and platinum, weakly positive.

The author has also studied the action of heat on the zinc-copper-water element, of which he states the electric motive force becomes augmented, while it is enfeebled by light.—*Scientific American*, xxxvii, 193.

Influence of Wine Bottles on Wine.—It has recently been determined in France that wine may be injured through the glass of the bottles in which it is contained, being too alkaline. According to analyses given the *Revue Industrielle*, glass for wine bottles should yield per 100 parts: silex, 58·4; potash or soda, 11·7; lime, 18 6; clay and oxide of iron, 11; other ingredients, 0·3. Glass in bad bottles has been found to contain, silex, 52·4; potash or soda, 4·4; lime, 32·1; clay and iron, 11·1. It seems that the wines suffers principally from excess of lime. Thus, in glass composed of silex, 45, soda, 15; lime, 30; and clay, 15, for example, the wine became thick and lost its aroma. The best bottle glass contains from 18 to 20 parts lime and 59 to 60 silex; the worst, 50 to 52 silex and 25 to 30 lime.—*Scientific American, xxxvii*, 193.

Coloring Wool.—It is pointed out in Reimann's *Farber Zeitung* that fabrics, especially those of wool, which have for a long time been exposed to air and light, acquire a stronger power of fixing coloring matter than portions of the same material which have been kept in the dark. This circumstance often prevents the production of an even shade, those parts on which the light had fallen taking the light more readily and acquiring a striped or banded appearance.—*Scientific American*, xxxvii, 200.

New Researches on Metal Davyum.—M. Serguis Kern, the discoverer of the new element Davyum, publishes in the *Chemical News*, a paper containing some late researches upon the chemical behavior of salts of davyum of which the following is a brief abstract:

Potassium hydroxide gives a light lemon colored precipitate with solutions of davyum chloride readily soluble in acids (even in acetic acid), and solutions of davyum chloride, are precipitated (brownish) by yellow prussiate. Potassium cyanide readily dissolves davyum chloride, and the solution in evaporation yields large prisms of the double cyanide of potassium davyum. Hydrogen sulphide gives in acid solutions of davyum chloride a brownish precipitation, which readily dissolves in alkaline sulphides. Potassium sulpho-cyanide gives with davyum chloride solutions, a red colorative, (the absence of iron was established.)

Davyum chloride is soluble in water, alcohol or ether; it is stable in the air, and not hygroscopic. Of forms double chloride (of dark red color) with potassium, thallician &c., insoluble in water, and soluble in absolute alcohol. The double salt of sodium and davyum is nearly insoluble in water and alcohol. This reaction is characteristic. Davyum sulphate is nearly insoluble in water, color, orange. Specific gravity of the metal is 9.385. The atomic weight is not yet determined, but it is supposed to be near 154 The quantity of davyum thus far prepared is extremely small, and experiment is difficult.

Feeling Pulse by Telegraph.—Some months ago Dr. Upham, of Salem, Mass., in order to explain to his audience the variations of the pulse in certain diseases, caused the lecture-room to be placed in telegraphic communication with the city hospital of Boston, distant 15 miles, and by means of special apparatus the various pulse beats were exhibited by a vibrating ray of magnesium light upon the wall. These experiments have lately been repeated at Paris with success.—*Druggists' Advertiser*, ii. 180.

New Process for Electro-Plating.—Professor A. W. Wright, of Yale College, New Haven, Conn., has discovered a new and brilliant method of electro-plating, which promises to be of great utility. Taking advantage of the fact that the various metals may be volatilized by the electrical current, he provides a hollow vessel, from which the air is partially exhausted; within this vessel he arranges opposite to each other the two poles of an induction coil; the article to be electro-plated, a bit of glass for example, is suspended between the poles; to the negative pole is attached a small piece of the metal that is to be deposited on the glass. From three to six pint Grove cells are employed, yielding, by means of the induction coil, an electrical spark from two to three inches in length. Under the influence of this spark a portion of the metal of the electrode is converted into gas or volatilized, and condenses upon the cooler surface of the suspended glass, forming a most brilliant and uniform deposit. The thickness of the plating thus produced may be regulated at will, by simply continuing the action of the electricity for a longer or shorter period. That the metal is actually volatilized is proven by examination with the spectroscope during the progress of the operation, the characteristic lines of whatever metal is used for the electrode being fully revealed. This may be classed as the discovery of a new art, and is certainly very interesting and remarkable. In brief, it consists in plating the surfaces of substances with metals, by exposing such surfaces to the hot vapors of whatever metal it is desired to plate with.

Professor Wright has already made a number of valuable practical applications of his discovery. He produces mirrors with silver, platinum, iron, and other metals, of the most pure and resplendent character. He deposits gold in a layer so thin that it is only 0·000183 mm. in thickness, or approximately only one-fourth the wave length of a red ray of light. He obtains curious colors in the metals, varying with the thickness of the deposits, and opens up a new field for investigation into the nature of metals and other volatilizable substances, and perhaps of light. He shows that his electrically deposited metals have improved qualities; that telescopic and heliostatic mirrors, for example, of platinum deposited on silver, by his process, will be unalterable; and the promise is that we shall before long be able by this new art to produce telescopes and other scientific instruments of greatly improved character.—*Scientific American*, xxxvii, 177.

Detection of the Artificial Coloring of Brandy.—It is a well-known fact that the longer brandy is permitted to remain in the cask the darker it gets in color—due to the taking up of the coloring matter in the wood. Liquor dealers have a strong inclination to have nothing but old brandy, so-called, in stock, therefore color their young liquor by means of burnt sugar (caramel). This falsification is at once apparent to the practical tippler, but a chemical test is nevertheless very desirable. Herr E. Carles discovered that the falsification referred to can be detected by means either of the albumen of an egg or sulphate of iron. If to two samples of brandy, the one colored by natural means, the other by sugar, one-sixth of their volume of albumen be added, they will become turbid. On clearing, either by being permitted to stand quietly or by filtration, the artificially colored liquor will retain its color while the unadulterated will be almost colorless. The addition of a concentrated solution of sulphate of iron will not affect the tampered liquor, while the true article will be colored to a blackish green color, more intense as the brandy is aged.—*Fresenius' Zentschrift.*

An Improved Gas-Burner.—For the purpose of better regulating the distance of the flame from the object to be heated, Mr. Robert Muncke has added an improvement to the well-known Bunsen's gas-burner, which consists of an elongation-tube movable up and down the burner with sufficient friction to remain at any given height. An ordinary burner of 160 mm. ($6\frac{1}{4}$ inch.) height may thus be lengthened to 250 mm. ($9\frac{7}{8}$ inches). When requiring the use of the triangle for supporting chimneys, etc., in combustions, or incinerations, the sliding tube and triangle are in piece. This contrivance does away with the inconvenient wooden supports or blocks, which it is often impossible to exactly adjust to the proper height.—*Ber. d. Deutsch. Chem. Ges.* 10, 538.—(*New Remedies.*)

Salicylic Acid is being largely advertised in France for preserving wine, beer, and cider during the summer heats, and for preserving milk and *bouillon* from souring; also for aiding the preservation of jams, jellies, and other confections, with an economy of sugar, said to amount to 25 per cent.—*N. Rem.* vi, 288.

Chinese Kaolin.—Professor A. Bauer, of Vienna, remarks in our contemporary *Papier-Zeitung* that he received some samples of Chinese Kaolin from Kiukiang, and which he found on analysis to possess the following composition:

Composition in 100 parts.	1st quality.	2d quality.	3d quality.
Soluble Silicic Acid	0,504	52,208	51.210
Insoluble " "	50,133		
Alumina	32 737	31,997	33,150
Ferric Oxide	0,955	0,712	0,709
Ferrous "	1,690	1,911	1,936
Manganous Oxide	0,827	0,504	0,843
Lime	0,501	0,464	0,456
Magnesia	0,268	0,273	0,284
Potassa	2,520	1,560	0,403
Soda	10,011	0,970	0,992
Loss on ignition		9,499	9,500
	100,146	100,098	100,483

These analyses show that the Kaolin contains besides the main constituent (silicate of alumina) only a small proportion of impurities. The relatively small quantity of soda in comparison with the percentage of potassa, proves that the Kaolin of Kiukiang has resulted from the weathering of a rock rich in potash.

Utilization of Ivory and Bone-Dust.—In the manufacture of paper knives, keys for musical instruments, and other articles, large quantities of ivory dust are annually produced, and endeavors have been frequently made to utilize it by means of some agglutinative solution which would enable the mass to be molded into various forms, but hitherto attempts of this kind have not met with success. Much of the clean ivory dust is boiled to obtain the gelatine, which makes excellent jelly when suitably flavored, and the refuse is sold to manure makers. M. Latry, however, has described to the French Society for the Encouragement of Industry a method by which ivory dust and the dust of bones can, by a means of an agglutinative substance, and under the influence of a high temperature and compression, be molded into various articles, suitably colored, and of extreme hardness.—*Iron age, xx*, 11.

ENGINEERING—CIVIL AND MECHANICAL, &c.

A New Explosive Bullet.—Capt. C. S. O'Hara, of New Orleans, La., lately made some experiments at the Crescent City Rifle Park with his new explosive and igneous bullet. A large chest made to represent the caisson of field artillery, was charged with powder and set on tressels. At a distance of one hundred yards a bullet was fired into the chest, which was blown up. Shavings and wood, in which there was no powder, was set on fire by being fired into. A post was rigged as a ship's mast, with a yard of sail furled. This was shot at and partially burned, the canvas readily igniting by the explosion of the bullet.

The inventor claims that shells or bullets of any size may be made on the same principle, and the material with which they are charged may be handled with as much safety as gunpowder, and that time and climate will have no deteriorating effect upon it.—*Scientific American*, xxxvii, 179.

The Channel Tunnel.—The engineers of the Channel Tunnel—MM. Polier and Lapparent—in a report upon the result of the numerous soundings which they have taken during the last eighteen months for the purpose of ascertaining the thickness and impermeability of the different strata in the Channel, state that "observation shows that the soil under the sea preserves the same characteristic as upon the French mainland—that is to say, a line traced upon the surface of one of the beds of chalk consists of long straight lines connected with one another with very pronounced sinosities. Observation has also shown—and this is a capital point with regard to the making of the tunnel—that of these sinuosities, of which there are two in the Channel, the strata are evidently continuous, and that the distance between the two successive lines is filled up, not by a fissure, but simply by a curve. There is, therefore, no reason for anticipating that the work will encounter any geological difficulties, properly so called, if we bear in mind the information furnished by a study of the sea's bed and by the work done in the mines which run down into the chalk. The boring at Sangatte has not been carried far enough to admit of any definite opinion being given as to the jurassical development of the soil in that region, but it has confirmed the deductions drawn as to the progessive diminution in thickness of the strata below the chalk, which runs from Boulogne towards Calais. These strata are formed of sand and clay, with an admixture of palæozoic pebbles, red calcareous and carboniferous marl, but without any rock of the coal order."—*Van Nostrand's Engineering Magazine*, xvii, 380.

The Sutro Tunnel.—Regarding the condition of this enterprise, the *Gold Hill News* of the 29th ult., says: "The face of the tunnel has now reached a point 300 feet west of shaft No. 4, and 642 feet east of a direct north and south line from the Savage-Chollar-Norcross combination shaft, which point is 18,439 feet from the mouth of the tunnel. The flow of water from the header is 73 inches. The temperature of the water at this point is 94°, and at the mouth of the tunnel 77° Fahrenheit. The temperature of the air at the header is 97°, but it is pure, and the men have no difficulty in working. The compressed air for driving the drills in the face and ventilating the tunnel, is brought from shaft No. 2, a distance of 10,487 feet. Since the first of August the average daily progress has been about 11 feet, so that, if nothing serious happens to prevent, the total progress for the year 1877 will not fall much, if any, short of 4,000 feet. At the present rate of work an average of 2,000 car-loads of rock, weighing two tons each, is removed monthly. A drain tunnel 1,100 feet in length has been completed from east of the machine shop, at the mouth of the tunnel, and a shaft 60 feet in depth to the level of the tunnel. The design of this drain is to create a fall of 60 feet for the water to obtain a power sufficient to run the entire machinery of the machine shop, without the cost of steam. The water from the tunnel will be turned downward through this shaft, at the bottom of which one of Leffel's 13½ turbine water-wheels will be placed, capable of making 700 revolutions per minute, and which will furnish 50 horse power. This, it is estimated, will run with ease the entire machinery of the shop. The water, after passing through the drain, will then be used for irrigating purposes by the farmers along the banks of the Carson. The total number of men employed at the tunnel, including foremen, clerks, miners, and other employees, is 82. There are rumors again of a compromise between the great mining-managements of the Comstock and the Sutro Tunnel Company. Such compromise, if satisfactorily arranged, would be very advantageous to both parties. As has heretofore been stated and shown in the *News*, in less than three months' time from now a connection could be made between the tunnel and the bottom of the Chollar-Norcross Savage Combination shaft, and thus through into the Chollar mine, giving not only good and important ventilation, but the drainage of the lower levels of the Comstock could then be commenced by pumping and passing the water of the Savage and Norcross through to the tunnel, thus saving at least 1,500 feet in height of pumping." The total length of the tunnel on the 29th ult. was 18,011 feet; it had, therefore, 423 feet to go before reaching the point which would bring it directly in a line with the Savage Chollar-Norcross joint shaft; at the present rate of progress this point should be reached in November. The face of the header is in soft porphyry and clay, with occasional streaks of quartz. It is in the regular Comstock vein material. Water decreasing somewhat. The Lyon County *Times* of the 5th inst., says: "Well-informed parties assert that a ledge has been passed through or penetrated by the Sutro Tunnel that is over twenty feet wide, and assays about $100 to the ton. This may account for the proposed mill to be erected within ninety days."

Refrigerating Cars.—Experienced gentlemen who have examined the Tiffany cars and had their mechanism explained to them by Mr. D. M. Turner, agent of the company, state that by means of these cars fresh meat can be transported at all seasons from the extreme South and South-west, where it is comparatively worthless, to markets where it is wanted. The first effort of the patentee, Mr. Joel Tiffany, of Chicago, was to get a car which would be acceptable in all respects to railroad managers. It is consequently much lighter than most refrigerator cars. Its walls are composed of several partitions, lined with non-conducting substances, and between the partitions on all sides of the car are spaces filled with confined air, which furnish the principle means of insulation. This method of insulation causes economy of ice, and prevents much of the accumulation of water customary in refrigerator cars, and which is one serious objection made to them. Mr. Turner is a thorough convert to this method of insulation. He reports that he charged one with ice in Kansas City on the 8th of August, after it had been standing three weeks in the hot sun, and 24 hours after icing only 400 pounds of ice were required to replace what had melted in cooling off the hot car. Besides being employed to transport meat and produce in hot weather, the Tiffany cars will also be utilized for the transportation in winter of fruit, fresh meat, vegetables, and other articles liable to injury by extreme cold weather. The cars have been tested for this purpose with the most satisfactory results.—*R. World*, iii, 894.

Work on the New Bridge of the Lake Shore & Michigan Southern R. R. across the Maumee at Toledo is progressing favorably. One pier is nearly finished. Another is nearly up to the water's edge. The two others are being started. The building of all four will be completed in about two months. The bridge will be of iron and equipped with double steel tracks. When completed it will be one of the finest structures on the road. The work will be pushed rapidly forward, and it is expected that the trains will be moving over it early in the spring.—*Engineering News*, iv, 261.

Safety Stoves for Railway Cars.—An invention that seems likely to counteract the most frequent cause of fires that break out in the wreck of railway trains, is announced from Omaha. Such fires are, in the majority of instances, kindled from coals that are thrown, at the time of the accident, out of the stoves that are used to heat the cars, and it is easily capable of proof that the burning of railway wrecks occurs more frequently during the seasons of the year when cars are heated than when stoves are not used. The ingenuity of inventors has been chiefly directed toward obviating this risk by making the stoves so secure as not to spill the fuel when upset, but such contrivances meet with only partial success, because of the possibility that the concussion may be so violent as to break the stove to pieces. There have been several ingenious devices for obtaining heat without fuel-burning stoves, but they do not seem to have met the want, though one of them—a foot-stove in which lime was slacked—was said to be successful in Germany, but would not be likely to serve in our climate. The invention shown at Omaha is of a much simpler kind. Its design is to put the fire in a stove, in case it is wholly or partially upset. This is accomplished by surrounding the stove with a jacket containg water. Openings in the jacket communicate with the interior of the stove, so that, if the car is much tilted from a level, the water will flow into the stove and extinguish the fire. If the details of the invention are as simple as the essential idea, there should be nothing in the way of its success. —*R. World*, iii, 894.

A Revolving Shell Gun.—A correspondent with the Turkish fleet writes: "In speaking of the armament of the Arsari Tefyk, I should mention that a most valuable addition has lately been made in the shape of a revolving shell gun. It is the invention of a Frenchman, and, in connection with the electric light, may be considered as the very best defence yet brought out against torpedo boats. It throws a one pound shell with a pointed steel head capable of piercing the plates of which the Thornycroft is constructed, and has a range of something like 3,000 yards. Briefly described, it is a Gatling gun on a large scale, having five revolving rifled barrels instead of ten, the said barrels being about 3½ feet in length, and 1¾ inches bore at the muzzle. The loading and firing arrangements are similar to the Gatling, only, instead of a cylindrical case being placed on top of the breech, the cartridges are arranged in flat cases of five, which are fixed in an inclined position at the side. The turn of the handle causes one of the cartridges to slip into the chamber, when it is thrust forward into the barrel and fired. This weapon is fixed on a pivot at the stern, while a Gatling gun at each end of the bridge, and one on the forecastle, are also always ready for giving a warm reception to any of the enemy's boats which may attempt to approach the Turkish flagship while at anchor.—*Scientific American*, xxxvii, 182.

Iron Sailing Ships.—Up to last year only one iron sailing ship had been built in the United States. There were iron shipyards enough, and competent builders, and the builders were offering to construct vessels as cheap as they could be bought abroad, and as an illustration of what they could do in shipbuilding they have been producing some of the fleetest, staunchest, and most beautiful iron steamships which sail in and out of the ports of the United States, but no one ordered an American iron sailing ship. From various causes shipmasters were content with wood. There now, says the New York *Tribune*, begins to be an inquiry, however, concerning American iron ships. The statement that such vessels can be built as cheaply in this country as abroad has attracted wide attention, and a prominent builder is now in receipt of letters from Boston and Liverpool saying that if he can build iron sailing vessels at the rates claimed the writers will certainly order ships from him. The rate in England for a first-class iron vessel of, say, 1000 tons burden, with a double outfit of sails, is about £9 per ton. The offer is made to construct the same sort of ship precisely for $45 a ton, in currency.

Record of New Railroad Construction.—The *Railway Gazette* of Sept. 28, has information of the laying of track on new railroads as follows:

Rochester & State Line.—Extended 6 miles, to Gainesville Creek, N. Y.

Lade George & Muskegon River.—This lumber road in Clare county, Mich., is completed 7 miles from the Muskegon river.

Maple River.—Extended west by north 23 miles, to Ida, Iowa.

Omaha & Republican Valley.—Extended from Wahoo, Neb., west to David City, 42 miles.

Tyler Tap.—Completed from Tyler, Texas, north by east to Big Sandy, 20 miles.

Utah Western.—Extended from Tooele, Utah, south by west to Stockton, 9 miles. It is of 3 ft. gauge.

This is a total of 112 miles of new railroad, making 1,335 miles completed in the United States in 1877, against 1,599 reported for the corresponding period in 1876, 761 in 1875, 1,082 in 1874, 2,691 in 1873, and 4,765 in 1872.—*Railroad Gazette*, ix, 438.

Cement for Leather Belting.—Take common glue and American isinglass, equal parts; place them in a boiler and add water sufficient to just cover the whole. Let it soak ten hours, then bring the whole to a boiling heat, and add pure tannin until the whole becomes ropy and appears like the white of eggs. Apply it warm. Buff the grain off the leather where it is to be cemented; rub the joint surfaces solidly together, let it dry for a few hours, and it is ready for practical use; and if properly put together, it will not need riveting.—*Scientific American*, xxxvii, 183.

The Eddystone Lighthouse, built by Smeaton, on the celebrated rock of that name in Plymouth Sound, is to be taken down, according to report, not because of any instability in the building, but of the weakening of the rock itself under the action of the sea. It is proposed to re-erect this model lighthouse on the mainland, that its materials, at least, may be preserved in their original form. It is the third structure on that rock, and was erected in 1756-59.—*Eng. News*, iv, 262.

MINING, METALLURGY AND MINERALOGY.

Optical Characters of Minerals.—A new method of studying characters of minerals was described by Mr. Sorby, F. R. S., in a paper read before the British Association. The author first described the principles on which this method depended, and that the great difference between the appearance seen with the naked eye and the microscope is due to the object-glass being able to collect divergent rays. In looking with a low magnifying power at a small circular hole seen through a section of a crystal, very different phenomena present themselves, according to its optical characters. If double refraction only one well-defined circular hole can be seen. If the mineral possess double refraction and only one optic axis, like calcite, two images of the hole are seen. If the section be cut perpendicular to the axis, two circular holes are seen directly superimposed, but at two different foci. If the section be in the plane of cleavage, two widely-divided images are visible, the one due to the ordinary ray being circular and the other due to the ordinary ray being distorted and drawn out in two opposite planes at two different foci. When the section is cut parallel to the axis, this image due to the extraordinary ray is still more elongated, but the images are directly superimposed. We thus at once learn that the mineral has double refraction, has an optic axis, and also what is the direction in which the section is cut. In the case of crystals like Arragonite, which have two optic axis, there is no ordinary ray, and at the focal points we see the circular hole drawn out in opposite planes into crosses. The character of these crosses depends upon the direction of the section, but the fact of the crosses being seen at once proves that the mineral has two optic axes. Some facts are better observed if, instead of a circular hole, we examine through the crystaline plate a grating with two systems of lines at right angles to one another. We then obtain what the author calls unifocal or bifocal images, according to the system of crystallisation. Crystals with double refraction have only one unifocal image; crystals having one optic axis have one unifocal and bifocal image; whereas crystals having two optic axes give two bifocal images. The definition of unifocal is independent of the position of the lines; whereas in the case of bifocal images the lines are distinctly visible only when they are parallel or perpendicular to a particular axis of the crystal and, spread out, become obscure and disappear when rotated to a different azimuth. The above-named general characters differ so much in different minerals that they furnish a most valuable means for their identification.—*Eng. Mech.*, *xxvi*, 6.

Quicksilver in California.—There is every reason to to believe that the cinnabar deposits of California are inexhaustible. The new Almaden mines which are still worked, are at present the chief source of supply. Last year the yield of of quicksilver in the State was over 75,000 flasks. Since 1850 the total product has been some 860,000 flasks, representing a value of $50,000,000. For the last twenty years the total exports of quicksilver have been over 600,000 flasks, and the export is yearly increasing. China is California's best customer for the liquid metal. Within the last two years and a half nearly 62,000 flasks have been shipped to Hong Kong.—*Engineering News x*, 262.

A Precious Limestone has been found at Tehachepa, Kern County, California, which is said to be identical with the "giallo antico" (ancient yellow) marble of Italy. The latter is highly prized by antiquarians, as the location of the quarry from which it procured has been unknown for several centuries. The California stone is described as white with amber-colored veins. A specimen has been presented to the State Geological Society.

The Production of Noble Metals in Russia.—According to the statistics which relate to the subject, the production of silver during 1876 amounted but 156 pud, valued at about 142,360 ruble. 1617 pud of gold of 22,086,662 rubles value were produced during the same time.—*D. All. Polytech. Ztg.*, *v* 418.

The Telephone in Mining Operations.—The following extract from the London *Morning Post*, of September 6, shows that our suggestion that the telephone be used in mine signaling is received practically first from Dr. Le Neve Foster, the Government Inspector of Mines in Cornwall, and a constant reader of the *Engineering and Mining Journal*. The success achieved there will, no doubt, hasten the introduction of the telephone in our American mines.

It would be desirable to have stations at convenient points throughout the mine, so that the whole of the works would be under constant surveillance, as it were, and any accident in one part of the mine could be communicated to all other parts without delay.

"Hitherto no speaking signals to the surface have been possible in mines of great depth, and cord signals have been very indefinite. On Tuesday Dr. Foster and his brother, an electrician, conducted experiments at the Eliza Mine, St. Austell, with the telephone, which has never been tried in a mine. The little instrument, attached to a covered copper wire, was sent down the ventilating shaft, and within a quarter of an hour speaking at the bottom of the mine was distinctly heard, even more audible than at the bottom of the mine, where whispers at the top and songs were sung and questions asked and answered, demonstrating its thorough adaptability to mines. It was used by miners and others who had never seen the instrument before, and being so simple, efficacious, inexpensive, and quickly fixed, it might be in every mine in the country next week. An alarm calls attention when speaking is desired at either end. The importance of telephones in mining operations can scarcely be overestimated, as the wire and instrument is portable, and can be carried to the most extreme point of any mine.—*Engineering and Mining Journal* xxiv. 219.

The Borax Trade of Nevada.—The *Mining & Scientific Press* says: The borax trade, which was at one time not long since a very prosperous and apparently increasing one, has declined in extent so that most of the Nevada refineries are idle. The deposits of borax in Churchill and Esmeralda counties in that State are remarkably productive and practically inexhaustible. The importations of borax, which escapes the duty on manufactured articles, prevent the working of these deposits to a profit, so that the mines have been compelled to shut down entirely. There is one large house in England that completely controls this article of commerce, as other houses control quicksilver in Europe, and here manganese, asbestos, chrome ores, etc. This house has it in its power to put the price down so low that it will not pay to produce here, and when they found that competition was likely to effect their interests here, they reduced the price lower and lower, until our miners here were compelled to give in. At the same time they have their eyes on the Pacific coast deposits, and it was only a few months since that one of their emissaries was here examining the mines. If they get the control they desire, it is probable that some of the mines will again be worked, but not unless to their interests.

MISCELLANEOUS.

Cleansing Fluid.—For washing alpaca, camel's hair, and other woolen goods, and for removing marks made on furniture, carpet, rugs, etc.: Four ounces ammonia, four ounces white Castile soap, two ounces alcohol, two ounces glycerine, two ounces ether. Cut the soap fine, dissolve in one quart water over the fire, add four quarts water. When nearly cold add the other ingredients. This will make nearly eight quarts and will cost about 75 cents. It must be put in a bottle and stoppered tight. It will keep good any length of time. To wash dress goods, take a pail of lukewarm water, and put in a teacupful of the fluid, shake around well in this, and then rinse in plenty of clean water, and iron on wrong side while damp. For washing grease from coat collars, etc., take a little of the fluid in a cup of water, apply with a clean rag, and wipe well with a second rag. It will make everything wooden look bright and fresh.—*Chicago Tribune.*

An Electrical Plant.—The *Horticultural Gazette*, of Nicaragua, says *L' Union Medicale*, publishes some statements regarding a plant of the family of the *Phytolaccaceæ*, which grows in that country, and possesses electro-magnetic properties. When one touches a twig of the plant the hand receives as vivid a shock as from a Rhumkorff battery. The reporter, surprised at the phenomenon, made some experiments with a small compass. Seven or eight paces off the influence of the plant made itself felt. The deviation of the compass-needle was in proportion to the distance; the nearer it was brought the more marked the movement became, and when the instrument was placed in the middle of the bush the movements were changed into a rapid rotation. The subjacent soil did not contain any iron or other magnetic mineral. There was not any doubt that the electic quality resided in the plant itself. The intensity of the phenomenon varied with the time of day. At night it was scarcely perceptible; at two o'clock p. m. it attained its maximum. During a thunder-storm its power was increased, but when it rained the plant faded. The reporter has never seen birds perch nor insects light upon the *Phytollacca electrica.*

Glass and Bars for Roof Glazing.—We lately saw a defectively glazed glass roof under treatment toward restoring broken panes and stopping leaks. Counted by the acre, the surface of such glazing is enormous in the city of St. Louis, and would be increased were the immunity from leakage and breakage nearly assured. The system of glazing used on the roof of the Royal Aquarium, London, is held up as a model of this sort of protection and convenience; it consists of a series of zinc bars of pot hook section, with a return bend, the bars being screwed on the purlins. The top is simply a pot-hook or hanger section, at the bottom of the same section reversed. The glass rests in the groove of the lower bars and back groove of the intermediate upper one, in which it has full vertical play. The panes of glass lap each other; and the theory is, that no water can find its way inside the building covered by a roof glazed on this principle. The advantages of this system appear to be the diminution of breakage of glass from vibration, and expansion and contraction and other causes due to rigid fixing in the ordinary system, and the facility with which glass can be fixed or a damaged pane removed and replaced. The grooves carrying off water from the inside as well as from the outside is of course another advantage, for unless the roof be a very flat angle, indeed, water will not leave the glass, but will run down into the outside groove. Condensed waters and vapors are, therefore, thus well got rid of.

The Perils of the Cigar.—This is the manner in which the editor of the *Medical Record* expresses his feelings as to the baneful influences of the seductive weed:

"Of course there are plenty of men who believe that smoking is positively injurious. We have had it proved, over and over again, that the man who smokes is sure to die. Even the living smokers, who have by mistake grown old, cannot dodge this dreadful and indisputable issue. Then, again, before they die, these smokers are said to be addicted to loss of memory, (forgetting their promises to reform, no doubt), lack of will power (to stop the habit, perhaps), loss of sight, loss of muscular power, taste, smell, feeling, procreative power, and finally idiocy. All this is dreadful, and causes us to rejoice that, for a time at least, we have given up the use of tobacco. But there is really a serious aspect to this matter which deserves more than ordinary attention, and that is the liability of syphilitic contamination through the medium of the weed. Recently an English journal cited the case of a young girl, a manufacturer of cigars, who, with a chancre upon her lip, moistened with saliva the tips of all the cigars she made for a period of three days. This is a well authenticated case, and it is impossible to say how many more there are like it which are constantly spreading the dreadful poison to unsuspecting pleasure-seekers. The abominably disgusting practice of tobacco-strippers of moistening the lip with spray from the mouth, is, doubtless, an occasional, if not a common cause of infection."

Ramie.—M. A. Leger has recently made an exhaustive report on the cultivation of the ramie in France. Agricultural prospects throughout the southern parts of France are rather gloomy; the culture of madder is being abandoned everywhere, owing to the low prices which the competition of alizarine necessitates. The phylloxera has ruined the vine in four departments. Wheat will not pay so near Marseilles, which receives the supplies of Egypt, Turkey, and Russia. Other agricultural products, owing to circumstances of climate and soil, have little chance of being remunerating. The climate of the region is particularly suited to the ramie; the leaves form good feeding for cattle, while the uses of the fibre are extremely various.—*Paper Trade Journal, vi.* 297.

Meeting of the Franklin Institute—Bell's Telephone.—The first stated meeting of the Franklin Institute, since the summer recess was held on the evening of the 19th inst., the President, Dr. Robert E. Rogers, in the chair. The hall was filled in every part with members of the Institute and others. After the transaction of routine business, Hancock's inspirator, or compound injector for injecting water into steam boilers, was explained from a drawing on the screen. It is claimed that the machine is capable of lifting water twenty-five feet high and that it can be easily be adapted to locomotives.

The next experiment was with Bell's articulating telephone, several of the instruments being placed in the circuit in different parts of the room and connected with the office of Mr. Cornish, the agent, No. 1111 Chestnut street, through about half a mile of wire, the line being run in a very zig zag course. Conversation was carried on with ease, though talking at the other end of the line could only be heard by placing the ear to the mouthpiece of the instrument. After some experiments in speaking, the telephone on Chestnut street, was placed on a piano, no effort being made to concentrate the sound, and the tunes were heard quite distinctly by those listening at the various instruments in the Institute.

This telephone is constructed in the following manner: Attached to the end of a permanent bar magnet is a piece of of soft iron, which becomes charged with magnetism of the pole of the permanent magnet, to which it is attached. Around this piece of soft iron is wound a coil of fine wire. In front of the core of the coil, and at right angles to the axis of the magnet, is placed a circular piece of very thin iron, held firmly by its edges, and as close to the core as possible, without touching when vibrating. This plate or diaphragm is set in vibration by the sound waves in the air resulting from speech or other sounds, and in its approach toward and receding from the core of the magnet causes changes in its magnetic condition, and thereby inducing an electric current in the coil. When two such instruments are connected by a line wire by one end of the coil and the other end of the coil is connected with the ground, they are ready for use. By speaking in front of and near to one instrument, the disc, or plate, is set in motion, the current of electricity induced in the coil is conducted through the coil of the other instrument to the ground increasing and decreasing the attraction of its core for the diaphragm near it, and thus repeating the sound in the first and consequently setting up the same sound wave in the air. This telephone conveys the human voice so perfectly that one is able to recognize the voice of a particular individual. There is no battery attached to this instrument.

The Secretary, Mr. J. B. Knight, stated that by the experiments made in the afternoon with a "coil resister," it was found that reading could be heard over wire by this telephone a distance of 550 miles.

Bush's magneto-electric machine was then exhibited in some of its workings to the audience.

Experiments were made with the electric light, and the full power of the machine was shown by the burning of a block of zinc by the simple pressing thereupon of a brass or steel wire attached to the machine. This electric light was used as early as 1863 in one of the lighthouses on the coast of France. Electricity is produced by absolute force; a steam engine and no battery is used.

The workings of Baker's rotary pump (a modification of his rotary pressure blower) were also illustrated, and after electing Mr. Frederick Ransom an honorary member, the Institute adjourned.

Concerning the Recent Patent Office Fire.

We have received from Messrs. Howson & Son, of Washington and Philadelphia, the following statement concerning the late fire at the Patent Office.

PHILADELPHIA, September 26th, 1877.

Many mis-statements as to the results of the late fire in the Patent Office having appeared in the newspapers, the undersigned visited the building in Washington yesterday, with the view of advising clients and others as to the actual state of affairs. By a personal inspection of the Patent Office, he is enabled to publish the following:

The only portions of the building destroyed by fire are the North and West Model Halls, containing models relating to classes enumerated below.

Original Drawings. All these have been preserved, and such as were temporarily removed are being restored to their cases, the Draughtsman's Room itself being in no way injured.

The Library has received no damage with the exception of the slight wetting of some of the volumes of English Patents.

The Original Files of all patents are intact.

The Record Room, containing bound volumes of manuscript specifications and volumes of all printed specifications and drawings, indexes, letter books, &c, has not been injured.

Assignment Records are untouched, so that there can be no difficulty in determining titles.

Examiners' Room. These are uninjured by fire, but some of them are slightly damaged by water. The majority of the Examiners are at work as usual on pending applications, while others are re-arranging their rooms, and will be ready to go to work in a day or two.

Judging from the information obtained by the writer, the delay of business in the Patent Office will not be longer than five days from the date of the fire. The loss of models will not interfere materially with the duties of Examiders, as all drawings and documents, by which they have hitherto conducted examinations, have been preserved.

MODELS DESTROYED.—The models of the following classes have been destroyed:—Aeration and Bottling; Baths and Closets; Bee-hives; Bolts, Nuts and Rivets; Brakes and Gins; Bridges; Brushes and Brooms; Butchering; Carpentering; Carriages; Casting; Draining; Excavators; Fences; Files; Garden and Orchard; Glass; Grinding and Polishing; Hardware Manufacturing; Harrows; Harvesters; Hoisting; Horseshoes; Hose and Belting; Hydraulic Engineering; Journals and Bearings; Kitchen Utensils (partly); Manures; Masonry; Mechanical Powers; Metallurgy; Metal-working, (seven classes); Mills; Nails; Ore; Paving; Plows; Pneumatics; Presses; Pumps; Railways, (four classes); Roofing; Saws; Seeders and Planters; Sheet Metal; Stabling; Stone, Lime and Cement; Threshing; Tobacco; Tubing and Wire; Water Distribution; Water-wheels; Wire-working; Wood-working, (four classes).

MODELS SAVED.—The models of the following classes have been saved:—Apparel; Artificial Limbs; Beds; Beer and Wine; Bleaching and Dyeing; Boats; Book-binding; Boots and Shoes; Builders' Hardware; Caoutchouc; Carding; Chemical Miscellaneous; Clasps and Buckles; Clay; Cloth; Coffins; Cordage; Crinoline and Corsets; Cutlery; Dental; Drafting; Dryers and Kilns; Educational; Electricity; Felting and Hats; Fine Arts; Fire-arms; Fishing; Fuel; Furniture; Games and Toys; Gas; Governors; Harness; Ice; Jewelry; Knitting and Netting; Lamps and Gas-fixtures; Laundry; Leather; Locks and Latches; Measuring Instruments; Music; Needles and Pins; Oils, Fats and Glue; Optics; Ordnance; Paint; Paper-making; Paper Manufactures; Photgraphy; Plating; Preserving Food; Printing; Projectiles; Safes; Sewing Machines; Ships, (two classes); Signals; Silk; Spinning; Stationery; Steam Engine, (three classes); Stills; Stoves and Furnaces; Sugar; Surgery; Tanning; Toilet; Trunks; Umbrellas and Fans; Valves; Weaving.

Department of the Interior, United States Patent Office,
WASHINGTON, D. C., Sept. 27, 1877.

MY DEAR MR. HOWSON: Your circular of yesterday is upon my table. The office is under obligations to you for the prompt issue of it, and I have taken suggestions from it to give the

information to the Associated Press. The work of restoration is going on briskly, and the loss is less than I anticipated.

Of the many tons of copies of drawings stored in the attic, only a small portion are destroyed. Singularly, the flames scorched and blackened the edges, but left all the interior uninjured. I shall be able to save, I think, four-fifths of them. I am also saving every scrap of metal remaining of the models for future possible use. Most of the metal of the models is uninjured; many models, wholly of metal, are only blackened. The examining force is all at work, and to-morrow I shall have, I think, all the copying force at work. The examinations will not be interrupted. Truly yours, ELLIS SPEAR.

ANSWERS TO CORRESPONDENTS.

TO DYE HORN BLACK OR BROWN. (C. & D., New Haven.) Dip in a weak solution of salts of lead or of mercury, and then rub with solution of hydro-sulphate of ammonia; or mordant with a salt of iron and then dip in logwood.

SUBSTITUTION OF CHEESE FOR SALT MEAT. (R. M. D., Denver.) Your idea to furnish cheese to army and navy, instead of salt meat only, is a good one. Cheese is wholesome, more nutritious than butchers' meat, aids digestion, is always ready for use, needs no cooking, and is easily handled and transported.

PRESERVING MILK BY COLD. (H. B., Philadelphia.) In Lapland, reindeer milk is kept frozen for months; and we suppose that you might preserve milk economically by cold during the same period.

SHEARING. (C. S. R., Albany.) A shearing force acts in the plane of the section of a bar or plate. Thus in an ordinary shearing machine (see fig.) there is a shearing stress in plane $a\,b$, and the mean intensity of this stress is in the shearing force P divdied by the area a of the section $a\,b$. In Fig. 1 the forces PP act in the plane of section, and the stress is uniformly distributed, so that everywhere in the section it is $P \div a$. But as in Fig. 2 the forces act out of the plane of section, there is a *bending* stress too; the shearing stress is greatest at the middle of the section, and is zero at the upper or lower parts. A rivet connecting two plates is nearly always in shear; a bolt often so, especially in bridge work; so is a cotter or key. In these cases (see Fig. 3) the shearing forces act, not along line $b\,c$, but along the centres of the plates. The rapidity and friction of edges $a\,b$ and $c\,d$ cause the points of application of forces P and P' to approach $b\,c$, and then the shearing stress is uniformly distributed on $b\,c$. When the rivets fit loosely in the holes, as in Fig. 4, the rivet bends, and the stress distribution is unequal. When rivets fit the holes tightly, the shearing

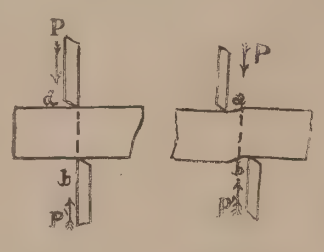


Fig. 1. *Fig.* 2.

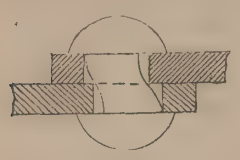


Fig. 4.

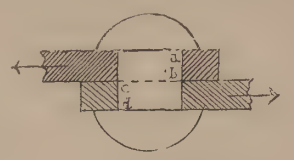


Fig. 3.

stress $f_s = P \div a$. For bolts and cotters the strain is apt to be unequally distributed, and the stress may mount up to $\frac{3P}{2a}$ when the section is rectangular, and P is perpendicular to one side; or $\frac{4P}{3a}$ if the section is circular or elliptical; or $\frac{9P}{8a}$ if the section is square, and P is parallel to a diagonal.

PROPORTIONS OF FLESH TO THE WHOLE ANIMAL. (M. J., Pittsburg.) In a 1,200 lb. beef there are about 700 lbs. meat, 100 hide, 90 fat, 50 blood, 20 of feet and hoofs, 10 of head bones and brains, 6 of tongue, 20 liver and milt, 14 lungs and heart, 60 intestines, 140 waste.

RENNET MAKING. (F. M. C., Hartford.) You have tried the wrong stomach. It is only the fourth stomach of a calf that is the true digesting stomach, and that properly makes a rennet.

SELECTED LIST OF U. S. PATENTS.

AUGUST 28, 1877.

Patents issued August 28, 1877, 251. Reissues, 8. Designs, 10. Trade-marks, 24. Labels, 10.

194,509. PIANO ATTACHMENT. C. Boecker and G. Fink, New York, N. Y.

A yoke is arranged to be moved across the path of the damper extension, and a rubber-covered wire in connection therewith is adapted to arrest and hold any desired damper out of use at will.

184,517. LOOMS. E. H. Graham, Biddeford, Me.

Improvement upon the loom covered by Letters Patent No. 153,711. The improvement relates to the lay and shuttle motions. The lay-swords have each a cam-slot, in which moves a stud, secured to a sliding block that is reciprocated vertically. The lay has a quick beat-up, in order to avoid striking the shuttle-carriers. The carriers are actuated by the combination of mechanism set forth in the first claim.

194,527. ATTACHMENTS FOR VERTICAL STEAM-BOILERS. C. M. Miller, Phelps, N. Y.

Two dish-shaped disks have openings through them, which register with each other, so that the openings are all closed or opened or partially so. Said disks are nearly equal in circumference to the smoke-box, so that when in position over the flame-tubes the smoke and gases are deflected to the outer annular space. The smoke-pipe projects down into the smoke-box, whereby the sparks and cinders are arrested.

194,546. AUTOMATIC STOPS FOR ELEVATORS. Jas. Beggs, Paterson, N. J. [Filed Aug. 1, 1877.]

Brief.—The gear-wheel and a disk with tumblers intervening are upon the same shaft. The disk remains quiescent during the hoisting operation, while the tumblers are revolved in succession, and just before the car-platform reaches its extreme movement the tumblers' stops come into contact with each other, and form a connection from the gear-wheel to the disk, and the latter is partially revolved. The stopping and starting lever is moved by a link from the said disk, so as to stop the engine.

194,551. COMPOSITIONS FOR SURFACING LEATHER. D. Flannery, Brooklyn, N. Y.

The within-described finishing composition, consisting of rosin, shellac, gum-arabic, Irish moss, gum-tragacanth, or equivalent resinous and mucilaginous gums, combined with borax solution and flax-seed, substantially as set forth.

194,593. MACHINES FOR WELDING TUBES. J. French, South St. Louis, Mo., assignor to himself and J. W. Hill, same place. [Filed May 21, 1877.]

Brief.—The slot in the hammer is provided with a rubber cushion, said cushion being protected from wear, and held in its place by a metal plate, which is secured by a bolt so placed as to serve also as a stop, against which the ends of the cam rest, to hold the hammer in an elevated position.

194,610. MACHINES FOR SEWING BUTTON-HOLES. Richard M. Melhuish, Hoxton, England. [Filed Mar. 17, 1876.]

Brief.—The needle works always in the same vertical line, and a lateral vibration and a longitudinal reversible feed are imparted to the work-plate, on which the fabric is clamped. The lateral vibration may be so regulated by adjustable cams as to first stitch one side; second, bar the end; and, third, stitch the other side of the botton-hole, the adjustment of the cams effecting the stoppage and reversal of the screw-feed.

194,630. MEASURING AND REGISTERING DEVICES FOR ASCERTAINING THE QUALITY AND QUANTITY OF DISTILLED LIQUORS. C. R. Wedelin, Gotheborg, Sweden. [Filed May 31, 1877.]

Brief.—A distilling-tank, a measuring-tank, and a testing-reservoir are connected by valves operated by one crank-arm, in such manner that the valves are operated simultaneously in one motion of the crank to fill the measuring vessel, and in the other to empty the measuring vessel into a suitable receiver, at the same time conveying a small quantity into the testing-reservoir.

194,638. MACHINES FOR BORING PUMP-LOGS. W. C. Barker, Horseheads, N. Y. [Filed Aug. 17, 1877.]

Brief.—Pump-logs of different sizes are securely held in hollow heads, provided with wedge-shaped blocks, while bored with a suitable cutting-bit, rigidly attached to an exterior tube projecting from a steam-box, the chips are carried or forced out by steam passing around an interior tube into the log at the bit, and then returning through the interior tube.

194,662. DEVICES FOR AUTOMATICALLY MEASURING THE AREA OF SIDES OF LEATHER. M. V. B. Ethridge, Lynn, assignor to J. H. Williams, Newton, and C. W. Holden, Boston, Mass. [Filed July 24, 1877.]

Brief.—A platen suspended from the arm of a balance is provided with a large number of headed metallic pins passing through holes in the platen, and free to move vertically. The hide whose area is to be measured is pressed up against the platen, and the platen is relieved of the weight of the pins resting upon the hide, the number being proportional to the area of the hide. The pins not supported by the hide exert their weight upon the balance, and a suitably-graduated scale and index show the area of the hide.

194,667. DEVICES FOR LOWERING FLUIDS INTO OIL-WELLS. S. A. Fithian and I. N. Fithian, Karns City, Pa. [Filed Feb. 17, 1877.]

Brief.—The cylinder filled with liquid is lowered into the well, and there discharged, for the purpose of cleaning the well by removing the paraffine, &c.

194,674. METHODS OF INTRODUCING PURIFYING AGENTS INTO IRON. Chas. W. Hall, New York, N. Y. [Filed July 21, 1877.]

In the purification of iron, the method of introducing the purifying agents into or upon the metals under treatment, which consists in placing the purifying and converting materials in the flame of the fire-box of furnaces when the iron is hot and near the point of melting, whereby the draft acts as a conveyer, substantially as described.

194,701. MANUFACTURE OF BREWERS' PITCH. Alfred Martin, Wilmington, N. C. [Filed July 10, 1877.]

1. The process of manufacturing brewer's pitch directly from crude turpentine, using oil of rosin instead of tallow or other oils, by first melting the turpentine and drawing off a portion, and then reducing the remainder by extracting spirits and acids before adding the oil of rosin and ochre, and, when drawing off the mass into a reservoir through a strainer, adding thereto the portion of turpentine first drawn off.

194,704. PUMPS TO REMOVE WATER AND PREVENT DEPOSITS IN OIL-WELLS. Chas. Means, Modoc City, Pa. [Filed Apr. 24, 1877.]

Brief.—The return working-barrel is sunk until the ends of the suction-pipe have passed the bottom line of oil-bearing rock or sand, the waste-pipe reaching to the upper level thereof. The pump being put in operation, will suck air only until the oil reaches above and seals the vent-pipe, when the pump will begin to lift the liquids from the well, first the contents of the return working-barrel, the water from the bottom of the well, then the oil.

194,717. SUSPENSION-BRIDGES. R. B. Osborne, New Castle County, Del. [Filed June 30, 1877.]

The combination, in one structure, of the suspension, Howe and Pratt system of bridge construction, arranged substantially as and for the purposes specified.

194,740. CIRCULAR LOOMS. B. L. Stowe, New York, N. Y., assignor to J. V. D. Reed, same place. [Filed Aug. 15, 1877.]

Brief.—The loom is designed to produce a tubular fabric of indefinite length. The vertical pick-ups are divided into two sets of long and short pick-ups, which are lifted by high and low cams. These cams are caused to travel around the circumference of the loom by the driving mechanism. The pick-ups are provided at their lower ends with lateral projections alternately arranged in opposite directions. The cams are shifted automatically, so as to engage during one revolution with the outer projections, and during the next with the inner. The warp-threads pass up onto a guide or lifter, that keeps the shed open during a revolution. A separator further divides the warp close to the edge of the tube where the weaving takes place. The arm crowds in the weft.

194,741. CIRCULAR LOOMS. B. L. Stowe, New York, N. Y., assignor to J. V. D. Reed, same place. [Filed Aug. 15, 1877.]

Brief.—The loom is a modification of the inventor's single-ply loom for weaving tubular fabrics, and is designed to weave a multiple-ply web. The vertical pick-ups are combined with levers provided with lugs, and are actuated by shifting cams. The loom shown and described is adapted to weave a three-ply fabric, and there are three sets of cams, each set consisting of two pairs of cams. The entire series of pick-ups is divided into sets of eight, each two of each set carrying the tie-warp threads, and the remaining six carrying the warps of the different plies, viz., two carrying the warps of the inner ply, two the middle ply, and another two the outer ply. The alternate rising and falling of the pickups produce the shed and the three separate sets of warp-threads for the different plies are carried up successively onto three guides, and the shed is thereby kept open during a revolution of the loom. The three weft-threads are packed as in the other loom. There are three segmental carriers, three weft-arms, and three separators, and the necessary operating mechanism is provided. The number of plies can be varied by a different division of the series of pick-ups, and a corresponding variation in the number of the cams and weft-carrying arms, &c.

REISSUES.

7,862. METALLURGICAL PROCESSES AND FURNACES. C. W. Siemens, Westminister, England. Patent No. 89,441, dated Apr. 27, 1869. [Filed Dec. 5, 1876.]

Brief.—Iron ore, mixed with reducing material, is charged into the upright retorts. Reducing-gases are passed into the center of the mass by the centrally-arranged gas-pipe. The retorts are heated by some of the waste heat from the furnace-bed The reduced sponge drops into the bath of cast-iron on the furnace-bed. Instead of upright retorts with iron ore, may use inclined retorts, with iron scraps, steel, or broken rails, &c.

7,864. VALVES FOR REGENERATOR-FURNACES. C. W. Siemens, Westminister, England. Patent 89,441, dated Apr. 27, 1869. [Filed Dec. 5, 1876.]

Brief.—Gas from the producer passes through one valve-box, past the reversing-valve, the side box, and onto the small regenerator and furnace-bed. Air passes in a similar way through the other valve-box, &c., and large regenerator to the furnace. The products of combustion come back through the other pair of regenerators, heat them, and pass to the chimney on the other side of the reversing-valve. On reversing this valve the courses of the air, gas, and products of combustion are also reversed.

1. In a regenerative gas-furnace, the reversing-valve, provided with metallic side boxes, substantially as shown and described.

EDITORIAL CORRESPONDENCE.

ED. POLYTECHNIC REVIEW:—

The Commissioner of Patents has issued the following circular for information of those concerned:

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *September* 26, 1877.

CIRCULAR.]

Inventors and their attorneys are informed that, so far as can be learned, none of the files of pending applications were lost in the recent fire, nor a single original document of any kind.

All models in the North and West Halls of the Model Room are destroyed. These include the following classes:

Aeration and Bottling.	Glass.
Agricultural Implements.	Hydraulics and Pneumatics.
do. Products.	Hoisting Apparatus.
Brakes and Gins.	Metal Working, (except about 500 models.)
Brushes and Brooms.	Metallurgy.
Bridges.	Mechanical Powers.
Butchering.	Presses, (except Printing.)
Capstans and Windlasses.	Quarrying and Rock Drilling.
Carpentering.	Railway, (except Locomotives.)
Carriages and Wagons.	Stabling.
Dairy.	Stone Sawing and Dressing.
Excavating.	Tobacco Machinery.
Fences.	Wood Working, (Tools and Machinery.)
Grinding Mills.	
Grain Cleaning.	
Garden and Orchard.	

A separate letter of inquiry concerning any particular case will receive attention.

W. H. DOOLITTLE,
Acting Commissioner.

It may be interesting to your readers to know that the loss is not quite so serious as indicated above. A number of the movable cases used at the Centennial Exposition were ranged through the centre of the North Hall. They contained horse shoes, tire setters, coolers, strinters and makers, wood screws, screw taps, dies and plates, nut locks, farriers' tools, anvils, cotton seed planters, and some others, and were removed bodily with their contents. In addition to these the class of harvester-cutters and guard-fingers were saved, and a few models from several classes located in the floor cases, including about forty models of harvesters. A considerable number of patented models were in the Examiners' rooms or elsewhere, out of their cases, and a very large number will be found in the debris with inconsiderable injury from the fire. Wooden models have been totally destroyed, but those which were made wholly or mostly of iron will be found in many cases but slightly injured. The heat in some portions of the halls was sufficiently intense to fuse copper, brass and glass, but it was not of long duration, and hence some slight protection was sufficient to preserve brass models with the lacquer scarcely tarnished. The walls of the building are not seriously injured—scarcely at all on the inner sides. The flagging of the floor is in many places thrown up, from what cause I do not know. It seems there was great inefficiency on the part of those in charge, or a much larger amount of property would have been saved. After it was known that the attic was on fire, it was half an hour before any fire engine arrived on the ground, and the general alarm was not turned on until after that. By the time the firemen got to work it is probable the West Hall was past saving, and the North Hall well on fire in the attic. The only thing which saved any part of the upper story is the brick-arched ceiling of the East and South Hall. Those halls are each partially unroofed, but the fire did not penetrate the halls themselves.

The origin of the fire is as yet unknown, but its spread was due to the most culpable negligence of the architect. To say nothing of a design which placed a practically wooden roof over such a building, there was no excuse for permitting the fire walls at the four intersections of the halls to be constructed with arched openings in the attic, as was the case here. Through these openings the fire traveled from attic to attic, until all four roofs were on fire, and two of them totally destroyed. It is not true that these roofs were supported upon wooden rafters, but they *were* of wood supported upon wrought-iron trussed roof frames, *without lateral bracing*, and when the wooden connections were weakened, these roof-frames went over like a row of bricks. I noticed one which in its descent turned a complete somersault.

The loss of the models is lamentable and can never be wholly repaired. It has forever destroyed the completeness of the most remarkable collection of mechanical exhibits in the world. Yet in most *essential* particulars it may be restored. 1. A considerable number of models are not destroyed beyond repair. 2. The drawings in cases patented within the last five years are mostly sufficiently complete to fully show all the invention. In many cases they are sufficiently complete to enable a skilled mechanic to accurately reproduce the model. 3. A very large proportion of the models of the older valuable inventions have been at one time or another duplicated for use in court, and many of these duplicate models, with the official certificate of duplication, will be returned to the office upon invitation of the Commissioner.

In removing the debris great care is being taken to save intact every model or fragment of model which may remain.

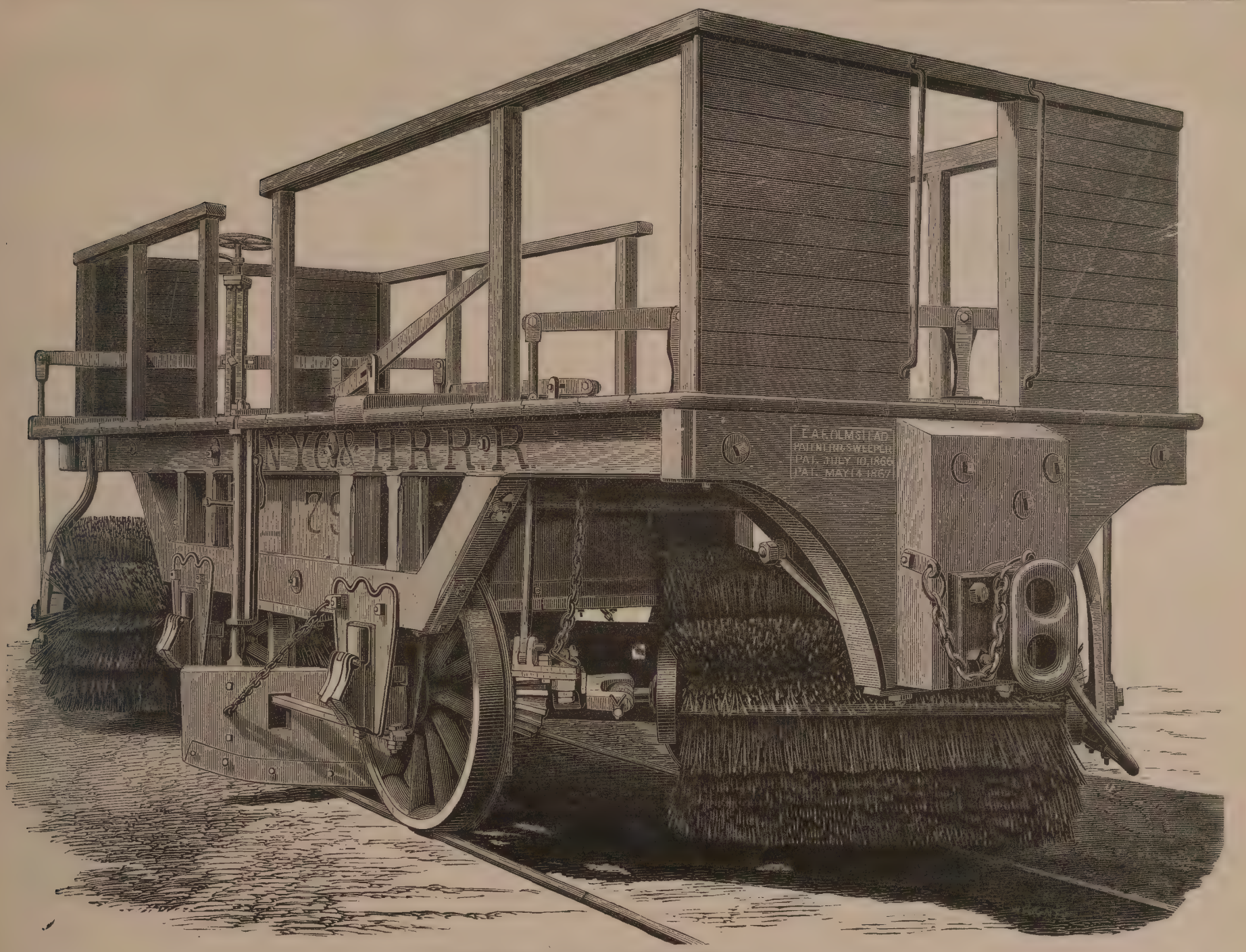
Truly yours, R. D. O. SMITH.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, OCTOBER 13, 1877. No. 15.



OLMSTEAD'S RAILROAD TRACK SWEEPER.

Since proper legislation has prohibited the use of salt by railroad companies for melting the snow upon their tracks, necessity has prompted the invention of other means by which the object of that faulty and dangerous system could be achieved.

We represent in the accompanying engraving the "sweeper" patented by A. F. Olmstead, of New York. This form of machine has almost entirely superseded the cumbrous snow-plow and sweepers with fixed brooms. As shown in the illustration, the sweeping mechanism consists of two cylindrical brooms, arranged diagonally under the fore and rear portion of the sweeper, and so arranged that each covers one half the track and one rail.

The lightest form of machine is intended for service upon street railway service. The weight is 7,500 lbs.; the frame is 21 feet in length; height of machine over all, 5 feet; fitted with spoke wheels, 42 inches in diameter, It is designed to run in either direction without turning. The brooms are made from cane, arranged upon shafts cylindrical in form, and are revolved from the main axles by gear-wheels and pinions; the pinion and broom-shafts are arranged with an eye and jaw, forming a joint, allowing the brooms to be raised and lowered parallel with the track. Scrapers are attached to each machine to relieve the brooms.

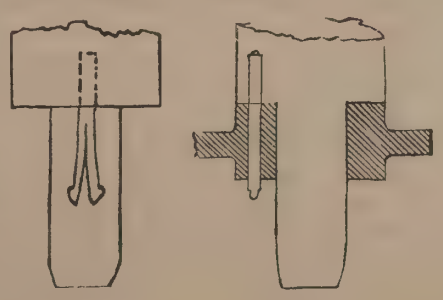
A heavier form of machine is constructed, and is designed for service upon steam railways. The weight is eight tons, but it is intended to be weighted down to a total of twelve tons when put into service. With a locomotive of sufficient capacity attached, this machine will sweep 15 inches of snow at a speed of 18 miles per hour.

A machine particularly adapted to small street railways, the broom shaft, instead of being raised and lowered parallel with the track, runs at its inner end in a ball and socket joint, and is arranged to raise and lower automatically by a counter balance; the brooms are arranged to be reversed when they become worn at the outer ends, and in this way can run down as closely as those which run parallel with the track.

The number of horses required to draw the sweepers will, of course, vary in proportion to the various conditions of track and the quality and quantity of snow to be removed. With six horses six inches of light snow may be swept without weighting the machines down; but if the snow is wet and heavy and deeper than six inches, the machines must be weighted down and plenty of horses attached to do the work. We think that the curtaining of the sides of the sweeper so as to prevent the snow and slush being splattered over the pavements and house-fronts in the narrow streets of our own and other cities, would make this machine even more popular than it is at present. O.C.W.

ANOTHER FIVE-DOLLAR IDEA.—SECURING CHANGE WHEELS.

In our last issue we gave a "five-dollar idea, sent on a one-cent postal card" by Prof. Sweet, of Cornell University, concerning an improvement in the teeth of back-gearing on lathes. We here present another from the same source, and hope that he and others will continue to favor us:

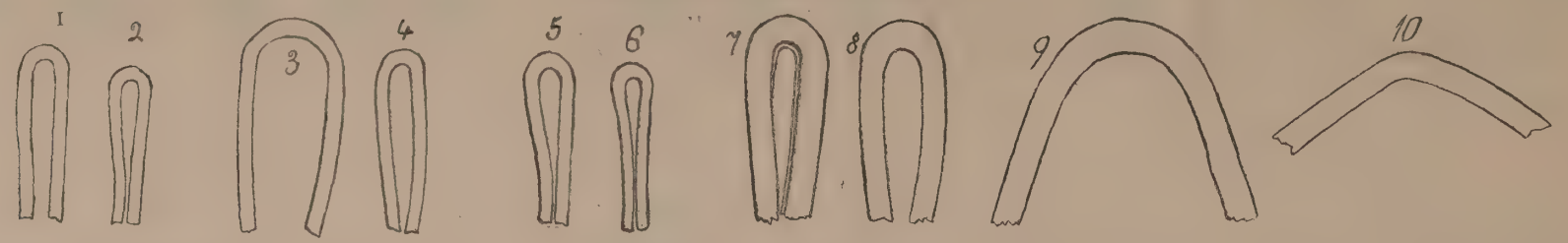


"In my unfinished papers on Lathes, I made the statement that the 'correct plan of securing change-wheels had not been invented.' We have since tried the plan below, and it works first-rate. The only objection is that it is not absolutely rigid The wheels fit either side to, and can be put on or taken off by a good push or pull.

The idea was put in its present shape by one of our students, F. A. Halsey."

Ithaca, N.Y. JOHN E. SWEET.

BEHAVIOR OF STEELS IN BENDING.



Some very elaborate experiments made at L'Orient, on Bessemer Steel from Terre-Noire, and Siemens Martin steel from Creusot, are recorded by Barba in his "Use of Steel;" and we reproduce here the results of those tests which were made to indicate the behavior of the metal under bending tests. Strips cut from plates or bars were hammered on the ends only (never where the flexion existed); sometimes the hammering was replaced by hydraulic force; but the curves were the same in both cases. In all cases bending was stopped as soon as the first crack appeared. Nicking the plates with a chisel (avoiding sledging, which might alter the grain) the specimens were broken by bending. The Bessmer showed a fine grain, slightly slate-colored and approaching the fracture of steel proper; tempering made the grain finer without altering the color. The grain of I beams was somewhat more steely than in the plates. The Martin metal gave a finer grained, whiter and brighter fracture, more rearly resembling that of fibrous iron; tempering scarcely modified it; it was of marked homogeneity. The strips were cut by a planer; Fig. 1 shows the mean deformation of the Bessemer plates, natural state, and Fig. 2 of the Martin, natural state. After tempering, the mean Bessemer deformations were as shown in Fig. 3; the Martin as in Fig. 4. After tempering and annealing, the Bessemer bent as in Fig. 5; the Martin as in Fig. 6. The tempering was done by heating to cherry-red and quenching in water at 50° F. Annealing was by heating to cherry-red. The Bessemer specimens were .31 inches thick; the Martin, .35; the test being consequently a little the harder for the latter. The tests in the natural state show the Martin metal to stand the test a little the better of the two; after tempering, the superiority was very marked. Annealing evidently brought the metals back to their normal state.

Testing with strips from I beams, natural, gave average deformations as in Fig. 7 for Bessemer flanges, Fig. 8 for Bessemer web. With tempered Bessemer I beams, the flanges gave results as in Fig. 9; the web as in Fig. 10. (The flanges averaging .53 inch thick. The web .42 inch). After tempering, cracks were observed in the flanges when bent as much as Fig. 9; in the web as soon as the angle shown in Fig. 10 was reached. The Bessemer I beams thus seem more changed in elasticity by tempering than the Bessemer plates.

In subsequent articles now in the printers hands we shall speak of the treatment of plates by punching, drilling, shearing, hammering, &c. G.

ON THE TEETH OF GEAR WHEELS.

SIDE NOTES FROM THE SCHOOL OF MECHANICAL ENGINEERING OF THE ILLINOIS INDUSTRIAL UNIVERSITY.

In a previous article an effort was made to show that when the teeth of gear wheels wear, while in action, the tendency is to wear out of correct form, and not with it as many suppose. Though teeth where shapes are merely guessed at, may improve their working condition somewhat by having some of their prominences knocked off, yet the very best shape assumed, under such circumstances, cannot approximate very closely to the form they ought to have.

The teeth of all gearing should therefore be given as correct forms as possible at the outset, with the supposition that the general outline can never be any better.

Of the forms of gear teeth which will work correctly, there is an infinite variety. But even infinity does not include those which are guessed at. We might say however that it comes half way, for the teeth of one wheel may be guessed at, and still work correctly with another wheel, the teeth of which are formed with due regard to theory for engaging with it. This shows that there must be a certain mutual relationship between the teeth of a pair of gears, a relationship that may not be satisfied even by correct gears when mismated.

Although, as above stated, the variety of *correct working* teeth is infinite, they are all determined by one and the same general principle, including even noncircular, as well as circular wheels; variety belonging to general shape and appearance of tooth, rather than principle. The forms usually adapted in practice by careful designers are epicycloidal and involute. In both of these the teeth may be made more or less strong by varying the relative thickness and base and point of tooth, which, especially in the former, leads to the variety of teeth known as epicycloidal teeth with radial flanks and curved flanks, teeth of change gears, and we might add epicycloidal teeth for a maximum of friction. Let us first consider the form which is most generally understood, viz:

EPICYCLOIDAL TEETH WITH RADIAL FLANKS.

In a great number of drawings and other books this is the only form of epicycloidal teeth treated of, and hence a great many draughtsmen who can lay out this form pretty correctly imagine they understand the whole theory of gearing, when, in reality their knowledge is confined to one very limited and special case. One object of the present paper and others that may follow, is to show up the general theory in the most simple language and terms, and its application to all forms of gearing required in practice. To reach this ultimatum in the theory, let us proceed step by step, first taking up the form above named.

Epicycloidal teeth are so named from the fact that the curves forming the outlines of the teeth are epicycloidal. To describe this curve, suppose a circular disk be cut from a half inch board and fastened down flat upon a paper on a drawing board. And suppose another circle cut, which may be equal, larger or smaller than the first. Fasten a tracing point to the latter so as to project downward from it at its circumference. Now place this wheel on the drawing board, against the first, or fixed wheel, and with the tracing point against the paper. Then by rolling it along around the fixed wheel, the point will trace the epicycloid. This curve will be proper for the face of a certain set of teeth for the fixed wheel. To be understood in what is meant by face, flank, &c., let us define the pitch circle of a gear as that circle which answers as the theoretical wheel: a circle into which the teeth vanish when made smaller and smaller or finer and finer until they disappear in a line. The pitch circles are a pair of wheels in proper action, therefore simply touch and roll upon each other. It is evident that the tooth distances, or *pitch*, must be laid off on these lines, and hence the name *pitch circle*, or *pitch line*. It is also evident that to secure an interlocking of the teeth they must extend above and below the pitch line on both wheels, or at least above on one and below on the other, as practically as possible. That part of the surface and one side of a tooth which lies above the pitch line is usually called the *face*, and the portion below the *flank*.

It is plain that a variety of epicycloids may be traced by varying the diameters of the circles used as above. By making the rolling circle smaller and smaller, a complete lobe or loop of the epicycloid, *i. e.*, the curve described by a simple revolution of the circle, will diminish and finally vanish into a point as would the circle itself. And conversely making that circle larger and larger; its radius finally becomes infinite, and the circumference a straight line. The epicycloid then becomes a sort of infinite spiral called an involute. Between these limits, it would seem that we ought to find an epicycloid which will be proper for the face of any possible wheel with radial flanked epicycloidal teeth.

To show how to find the tooth face for a particular case of radial flanks, let *A* and *B*, Fig. 1, represent the pitch lines of the pair of gears considered. And suppose *A* is fixed to the drawing board while *B* rolls upon it; the latter having a radius *B E* marked plainly upon it. For convenience of drawing, suppose a strip of tracing paper be tacked upon the board so as to lie *over* the two wheels, leaving *B* projecting so that it may be rolled along under the paper and kept against *A* without slipping. When *B* is at *G*, draw *D G* on the tracing paper. Again draw the radius for the center at *F*, and at *B*, and at *H* and *C*, at a considerable number of points. A curve *D L I* may then be traced in, lying just in contact with and, touching all the radii as shown.

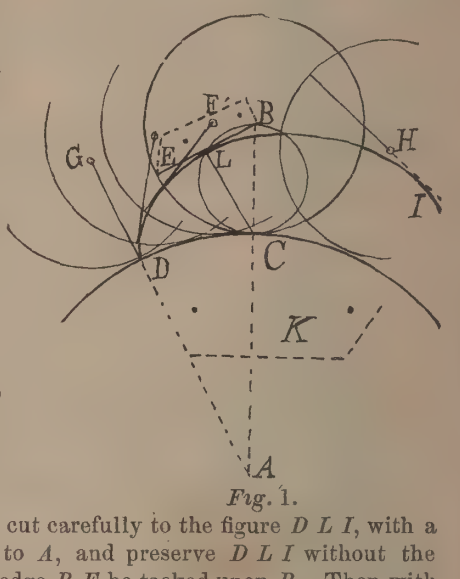


Fig. 1.

Now let a piece of wood or pasteboard be cut carefully to the figure *D L I*, with a wing left upon it so that it may be fastened to *A*, and preserve *D L I* without the tracing; also let a second block with straight edge *B E* be tacked upon *B*. Then with the two wheels placed in contact with *B E* against *D L I*, it is evident that *B* will all the while work close up to *D L I*, as *B* rolls upon *A*.

Now it is plain that the motion transmitted from *A* to *B*, by *A* carrying *D L I* against *B E* and thus turning *B*, will be just the same as though the motion were transmitted by the rolling of the circumferences of *A* and *B* upon each other. In circular gearing, such as now considered, this is the relation required, the circumferences of *A* and *B* being the pitch lines. In this case *B E*, inside the pitch line *B*, may be taken for the flank of a tooth of *B*; while *D L I*, outside of *A*, may be taken for the face of a tooth of *A*. By duplicating these curves upon *A* and *B* sufficiently often, the movement will become continuous.

Two points may be conveniently noticed here, which will be found useful afterwards.

1st, The contact between *D L I* and *B E* is always outside of wheel *A*, and inside of wheel *B*; and

2d, The contact for a reasonable length of tooth is always on the same side of a line drawn from *A* to *B*, which may be called the line of centers.

We have thus formed a curve that will serve for the faces of the teeth of *A* and work correctly on radial flanks of *B*. By repeating the same process with the wheels interchanged we obtain the faces of *B* and radial flanks of *A*. In this way the outlines for teeth may always be found in practice if preferred.

The curve thus obtained is as yet, of unknown form. If it were known we might see some more convenient way of drawing it. It suggests itself as an epicycloid, but it certainly is not the one obtained by rolling *B* upon *A* as described above, for the tracing point could not remain stationary on *B* and describe *D L I*.

Draw from *C* a line *C L*, *L* being the point where the curve *D L I* touches the radius *B E*. *C L* ought to be perpendicular to *B E*, and to the curve *D L*, because *C* is an axis of rotation for an instant for *B* to turn about, and *B E* should act toward *D L I* just as it would toward a circle described about *C*, that is, not shear into nor away from it: and this could only follow when *C L* is perpendicular to both *B E* and the curve. As this must be true for all positions of *L*, it follows that *C L* remains a common perpendicular to *B E* and *D L I* during the progress of the rolling. Draw a circle on the radius *B C* as a diameter; then *L* will lie on the circumference, if two chords, drawn from the extremeties af a diameter of a circle will meet at any point *L* in the circumfeaence at right angles. In geometry we have the proof of this as a fact, and any one may test it, practically, by drawing chords, thus from any number of points *L*, and measuring the angles.

Hence the circle whose diameter is *B C*, equal to the radius of *B*, having a tracing point *L*, will in rolling on *D C*, describe *D L I*, which is consequently an epicycloid.

We therefore arrive at this very important conclusion for epicycloidal teeth with radial flanks, viz:

To obtain the epicycloidal face for a tooth of one of the wheels, roll upon it a describing circle whose diameter equals the radius of the opposite wheel.

We should carefully note that the describing or rolling circle is only half as large as the opposite pitch circle; because writers, even, have sometimes overlooked this point.

S. W. ROBINSON.

(*To be continued.*)

LEATHER AND TANNING.

The conversion of skins into leather, or the art of tanning, was known by the ancients, and in all probability its discovery was accidental, since the astringent matter made use of abounds in vegetables growing on every portion of our globe. Different nations used skins to carry their water from the early part of their civilization. The beautiful fur rugs mentioned in the history of Cæsar, and the parchment that Cicero speaks of, evidently prove that the preparation of skins, with or without hair, was known in some degree of perfection. Our ancestors protected themselves in war by leather shields made of the hides of bulls from the forests of Poland and Russia.

During the reign of James I of England, patents of monopoly (for leather making) existed. George III repealed these in 1808.

It was not until the close of the 18th century that the structure of the skin and the action of the agents employed in tanning them became known.

The skins of animals consist of three distinct parts: the *Epidermis*, or outer layer, which contains the hair or wool; the net-like tissue beneath; and the *Dermis*, or that portion of the skin which, when tanned, constitutes leather, and yields, when dried, 43 per cent. of solid matter. The skins of almost all animals are fit for the manufacture of leather, but they vary much in tenacity and thickness. The thinnest parts of the skin are found on the belly, while the thickest is located on the back of the animal.

In sheep the thinnest portions of the hide are found where the hair is longest. The skin of this animal furnishes our market with the thin and cheap leather used for book-binding, bellows, chair coverings, etc. Goat skins are used principally for the manufacture of gloves—the finest qualities coming from Switzerland and Tuscany. Deer skins are *chamoyed* or dressed in oil, and were once largely used for breeches by the cavalry of our own and other countries; but owing to the fact of their slow drying, they caused rheumatic pains and were therefore abandoned. Horse hides are largely used for harness making, and hog skins for saddles.

The process of tanning is based on the combination of tannic acid with the corium of the hide. The vegetable materials used for tanning all contain tannic acid in a greater or lesser proportion. Tannic acid can be obtained in a pure state from gall nuts; if exposed to the atmosphere it changes to gallic acid—the presence of pyroligneous acid retards this change, while tartaric, malic, and the vegetable acids accelerate it. Oak bark is most commonly used to supply the necessary tannin. It should be taken from the tree in the spring of the year, when it contains about 6 per cent. of tannin.

Joseph Maitre has of late successfully practised in France a method of separating the bark from the wood by means of steam. The steam is generated in a boiler, and led by means of pipes into the barrels *a* and *b* containing the bark. The steam pressure is from 4 to 5 atmospheres.

In this country the *Abies Canadensis* is used in the form of an extract, containing 14.3 per cent of tannic acid, (this is often erroneously called hemlock); it is made and sold by the Thomas Extract Co., Elmira, N. Y. The bark of the elm, horse-chestnut and beech tree are all used, and contain from 2 to 4 per cent. of tannin. Larch bark is used for sheep skins. The young branches and twigs of the willow contain from 3 to 5 per cent of tannin, and are largely used by the Danes and Russians.

The *sumac* is one of the most important tanning materials known, it is the powder obtained from the leaves and stalks of a shrub called *tannis sumac*, its percentage of tannin is about 16.2. There exists a *Virginia*, and a *Carolina Sumac*, which contains about 5 per cent. of tannin. American tanners frequently use quercitron* (yellow oak) with great success. In Austria gall nuts are used with great success, they are called *Knoppern*. Galls are excrescences formed on oak leaves by insects. They should be used before fully developed. If attention is not paid to this, the insect will perforate the tissue of the gall. The Aleppo galls have been found to contain 60 per cent. of tannic acid. Dried acorn nuts, containing 40 per cent. of tannic acid are often used. The *catechu* and *kino* have for many years been used in tanning—the tree is to be found in Asia. The dividivi is the seed capsule of trees found in Central America; it is expensive and often used in dyeing. The most important tanning substances are bablah (20 per cent. of tannin), algarobilla seed capsules, (Chili), mirobolan from Bombay.

The tanner should be able to estimate of the per centage of tannin contained in the substances he makes use of. They frequently use what is termed a barkometer (a variety of hydrometer), this instrument gives far more satisfactory results than chemical analysis which is too complex for practical use. The most simple of all is to take a perfectly dried prepared skin and digest it with a known quantity of tanning material, the skin is subsequently washed, dried, and weighed, and the increased weight indicates the amount of tanning material required.

Preparation of Skins for Tanning.

Hides fresh from the slaughter house are washed, to remove blood and dirt, (if the hides be salted they must be soaked in water for 10 to 14 days) for this purpose a running stream is the best. The next treatment is the removal of the hair and fleshy substance, which is often preceded by a preliminary soaking of the hides in pits containing lime water (the refuse lime of the gas works, which contains sulphide of calcium, often gives good results).

The knife made use of is called the dressing knife, and the operation of dressing requires great skill on the part of the workman. To ascertain when the skins are to be removed from the lime pits, they are touched with the fingers to see if the hair still adheres. If the lime has acted sufficiently, they are taken out and placed on the beam (so called) and the hair scraped off by means of the hairing knife. When all this has been accomplished, the ears, tail, and legs are removed and the skins washed in water containing the dung of fowls or dogs to remove all foreign substances still remaining.

(Remark:—In this country the hides are frequently exposed for several days to foul air and sprinkled with water; after this the hair comes off with ease—this operation is termed cold sweating, and affords a larger yield of leather than any other method.)

For sheep skins, treatment with bran water is very advantageous since it makes them more susceptible to the action of tanning solutions. Barley meal, spent tan liquor and diluted sulphuric acid are likewise used. The disadvantage of the latter is that it injures the leather.

Great care should be taken not to bring the skins too rapidly in contact with the tannin, they are first immersed in a weak solution and then in a stronger. The quantity of bark employed is from 4 to 8 times the weight of the dry hides. The progress of the tanning operation is ascertained by examining from time to time a freshly cut edge of the hide, which shows the depth to which the tannic acid has penetrated.

The hides are placed in a horizontal position in the pits, at the bottom of which a layer of old tan has been placed. On this are placed alternating layers of hide and fresh oak bark until the pits are nearly full. On the top layer some two feet of spent tan is placed and the pit filled with water. After being left in this position for some three months, they are taken out and replaced in other tanks. After the tanning and drying is complete, the resulting product is termed leather.

L. S. Ware, C. E.

*A. D. Baer & Co., Baltimore, Md.

IMPROVEMENT IN MACHINES FOR STUFFING HORSE-COLLARS.

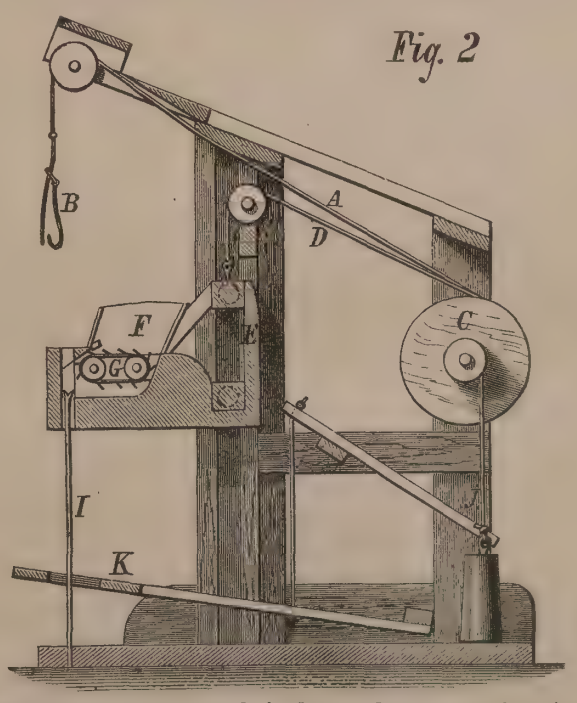
[Patented June 19th, 1877, by John M. Lichliter, Luray, Virginia.]

In using the machine the workman hangs the collar to be stuffed by one end from the hook *F*, and places the straw or other material in the hopper. He then takes the collar in his hand and holds its open lower end over the hole in the forward part of

Fig. 1

the carriage *K*, and presses the treadle down with his foot. The movement of the treadle raises the weight, and allows the carriage, *K*, to descend by its own weight, the workman drawing the collar down with it. As the carriage, *K*, descends, the forked

Fig. 2



rod forces the straw into the collar, which is drawn down upon it. As the workman raises his foot from the treadle, the weight descends and raises the carriage, *K*, the ascent of which operates the feed-belt, *M*, and feeds more straw into the cavity of said carriage, ready to be forced into the collar as the carriage again descends.

THE GRINDSTONE.

There is, perhaps, no implement in such general use and of so much importance as the much-abused grindstone. Although indispensible to mechanics, as a general rule, it is allowed to take care of itself, and as a matter of course such care is not of the best; from the time it is hung till it falls into pieces, there is not an hour spent upon it that can possibly be avoided.

We do not mean to imply that grindstones are *never* keep in good order, for in some shops where the proper pride exists, there is no fault to be found on this score; but in the majority of cases they are carelessly used and seldom repaired. Of a certainty, such neglect must show somewhere, and it usually takes the form of imperfectly or badly ground tools and waste of as much time as would be required to do the work well.

Some of those who own grindstones seem to think, if they spend any thought upon the subject, that they (stones) are a kind of luxury, and that the less time spent upon them the better; though if they would reason the matter a little, they would see clearly that more time is wasted every day than would pay for a man's time to keep the stone in good order.

It is astonishing to see some of the miserable apologies in use, going under the assumed name of "grindstone." A short time since we had occasion to use a stone in another person's shop—the best there was in the place—and actually it appeared as though designed for an eccentric, or more properly, a cam of very complicated motion, for it ran out about 1⅛", at once dangerous and aggravating to the feelings of the poor fellow who was compelled to use it. This is rather an exaggerated specimen of a bad stone, but it will serve to show up the point of neglect.

It is probable that the reason for such neglect mainly lies in the fact that what is everybody's business is nobody's business, for it is not reasonable to expect that a tool or machine that is nobody's work to look after and keep in order, shall be kept so. If one man had his orders to take care of the stone it would be kept right, but if this is not the case it will keep itself wrong.

There are a few important precautions that will insure the proper working of all job stones: do not allow them to run in water, but have the box deep enough to contain water below, and a pipe on such a level as to drain off any excess; then for supplying the stone have either a drip-can above or a stick in the trough to splash the water up from below. Some grits absorb an enormous quantity of water, and, of course, when the motion of the stone is stopped this settles to the bottom, causing a soft place, but this cannot be well avoided, unless the stone can be revolved constantly, which would be difficult to attain in practice. When hung, they should run as true as possible, sidewise as well as in the diameter, to reduce the work of turning, and should be faced all over so that the corners can be used—a very important point. They should be turned as often as is found necessary, and have attached, what is rarely applied, a cone pulley, this should not cost much and would keep the stone truer for different diameters than a single speed, and facilitate grinding, by having the periphery always travel at (nearly) the same speed.

A sharp lookout should be kept on the workmen that they do not cut grooves in the stone face by careless handling of tools, and that they do not use one side of the face altogether, thus wearing the stone to a conical form or making a large round corner, so that the next turning will reduce the diameter more than necessary to bring the corner sharp again. Sometimes it happens that when a stone is newly faced, a workman will ram a tool against the corner and ruin it for the time, and perhaps the tool he is grinding may just as well be ground in the centre of the face; this is mere carelessness, and can be avoided if hands are properly looked after.

If such precautions are taken, grinding will not be an annoyance to the workman, as he can do it to his satisfaction, and a large amount of time will be saved in the long run, besides the waste in stones will be reduced.

There is, perhaps, no accident that could happen to any tool in a machine shop, that would cripple it so effectually, as the breaking of a grindstone, for it is in almost constant use, and when it breaks down, tools become dull and unfit for use, and work must cease till the accident can be remedied.

As we have said, the uses of grindstones are innumerable, and they are found in all parts of the world, and even savage and barbarous nations use some form of grinding arrangement to sharpen their rude tools.

Of late there have been a great many improvements in machinery for utilizing the grindstone and adapting it to the various kinds of duty which it has to perform; such as machines for grinding circular, curved and straight work of all kinds.

With regard to the rest for general shop use, if meant for hand grinding, it should never be fastened rigidly to the frame. For, as the stone will wear out of true, accidents are liable to happen; if a tool catches, as likely as not the workman will have his hand injured, whereas, if the rest is free to move back it will afford space enough to prevent such injury. In case of a tool's catching, the stone suffers as well as the workman. The traversing rest is of much importance for straight work, and is used to some extent in planing mills for grinding planer knives, which is a very delicate and tedious operation by hand on an ordinary shop stone. But by the use of the traversing rest, even if the stone is not true, the work will be done as well, though, of course at the expense of time. If such rest is used it will keep the stone perfectly round, for, unlike hand grinding, the work is held perfectly rigid in the direction of contact, so that any inequality of hardness of grit will produce no effect in making the stone run out. But the use of the hand rest requires the work to be thrust hard against the stone, to accomplish anything, so that all soft spots will be worn away faster than the rest of the surface, leaving the face wavy and uneven.

Another device for retaining the proper shape is the double-hung grindstone, in which a pair of stones of different diameters are hung. The speeds of the peripheries are differential, and for every revolution the line of tangency is changed; in this manner any high spots are kept ground off of each and the round form is retained.

Finishing pulleys constitutes a large part of the circular work done by grinding on stones, and the system has been brought to such perfection that machinists find that they are saving in money buying pulleys in preference to finishing the same in their own shops. That is, after the grinder has his profit, the cost is much less than that of finishing in a machine shop. The amount of finish can be reduced, as scale makes no effect on a grindstone; whereas, it would be fatal to steel tools. In foundries, dry grinding is a decided improvement on the ordinary method, that of chipping, as it makes neater work and does not strain small and delicate castings as the jar of chipping. Beside which, where it can be applied, considerable time is saved, as also in place of pickling, if the work is not too complicated in shape for the stone to touch every part. For removing chilled fins from castings, grinding is the most practical and the cheapest method. Of course grinding for this purpose could only be applied where the nature of the work would admit, that is, small castings and the like, but there would be less complaint from customers on account of work made imperfect by having small pieces broken out in knocking off gates, &c.

Besides the uses already mentioned, the field of the much important grindstone extends to the manufacture of locomotives, saws, files, cutlery, edge tools, lap welded tubing, as well as to the shop, farm and domestic use.

There are many purposes to which grindstones are applied, for which nothing else would answer, and for some uses, they are of very little value when in competition with emery wheels; but, as before mentioned, for a large field of operation they are indispensible.

They operate well and are employed extensively for working all metals used in mechanical construction, such as iron and steel forgings, steel, iron and brass castings.

The kinds of grit are numerous, and are adapted to the kinds of work to which they are best suited. Roughing stones and all those used for removing any amount of stock are necessarily coarse, so as not to clog; those for finishing and grinding accurately, are medium or fine of either hard or soft grit; in short, the grade of the stone is like that of a file, suited to the kind of material and the class of operation to be performed thereon.

The selection of grit is of much importance, and sometimes buyers get out of patience because the stone does not suit, whereas; it is their fault for neglecting this point. Great care should be taken in making selection for speed stones, to ascertain surely the soundness and general applicability to the purpose desired, and when hung the speed should be adjusted to suit the stone; allowing them to stand in water is injurious, as also the practice, formerly used, of inserting a wooden plug in the eye of the stone. All proper precautions should be taken and frequent inspections made during the period of use, to acertain the soundness of the stone, and serious accidents would often be prevented.

The introduction and use of the emery wheel have not so much taken away from the work of the grindstone as increased the field for grinding machinery. For although, of late years, emery grinding apparatus has been brought to such perfection, and so superseded the grindstone, in some kinds of work, it is probable that the latter will never be entirely discarded; in fact, that it will continue to be used extensively, for it is simple and cheap and performs satisfactorily what is required of it, provided it receives the proper attention to keep it in repair, an operation that *all* tools and machines in use absolutely require. E. P. T.

A SENSIBLE HEATING AND VENTILATING APPARATUS.

We describe and illustrate herewith a device which, from an examination of its construction, we have little hesitation in pronouncing it to be the most meritorious invention of its class that has been brought to our notice. The device is a stove, which perform the double function of heating and ventilation in a manner at once simple, rational and effective. "The Fire on the Hearth," as the device is called, will be seen by consulting accompanying sectional engraving, to consist of a drum situated above an open grate, so divided by a metallic bridge as to require the heated gases from the fire to curve about it and descend again before making their exit into the chimney. Surrounding this drum, and prolonged at the back of the grate to the bottom of the stove, is the outer shell, an air chamber being thus formed, into which the air may enter freely, and pass out into the apartment through openings provided for the purpose. From its construction, therefore, it is manifest that we have here an air warming and circulating opportunities, combined with an open fire, in such a manner that while the latter gives out to the apartment by direct radiation all the heat that is commonly afforded by the open fire place, flame and conbustion products instead of being allowed to escape up the chimney, carrying off without useful effect about seven-eighths of the heating effect of the fuel, are forced to pass by a roundabout course in contact with an extended surface of metal. The heat thus communicated to the drum is

in turn communicated to the air, which as shown by the arrows, constantly escaping into the apartment is constantly supplied to the air chamber, either from the neighborhood of the floor, or from the out-air by making a proper connection. In this manner then we have in addition to the direct radiation of the open fire a continuous circulation of fresh air throughout the apartment, which after completing the circuit of the apartment, is found to escape either through the fire place, or through crevices in doors, or windows, while fresh air from without continually takes its place.

The whole arrangement and operation will be apparent from inspection of the diagram here shown. It would, we think, be a difficult task to dsvise an apparatus much simple and perfect than this. It has all the advantages of the fire, the cheerfulness, direct radiation of luminous heat, and ventilating virtues that sanitarians love to dilate upon, without its wasteful consumption of fuel; combined with which it has the air warming and circulating qualities of the hot-air furnace, without its cumbersome size and considerable cost. "The Fire on the Hearth" is manufactured by the Open Stove Ventilating Co., 115 Fulton St., N. Y. W.

"TEN MINUTE" PAPERS.

By Prof. J. E. Sweet.

TOOLS AND THEIR USES.—XI.

In considering the objectionable features resulting from the twisting strain on a slide rest, it will be necessary to study carefully as many of the different conditions that a slide rest has to work under, as we can think of. It is expected to travel back and forth truly for turning and boring, external and internal screw cutting, right and left hand, to keep its position for facing, and be so constructed that wearing of the slides will not throw the cross-slide out of right angle with the bed. I cannot reason myself into any other belief but that a very large slide on the single V at the front of the lathe meets all these conditions better than any other form. The slide should be controlled as rigidly as possible along that part where the propelling power is applied and where the work is performed; and it should run as free as possible on the back side or that part away from the propelling power. The flat slide at the back cannot by any possibility bind, whereas as in either case, where the flat way is used or where the double V is used. To settle the question whether they have a tendency to bind, it is only necessary to consider what would be the result in an exaggerated case. Suppose a slide rest as only 20 inches long and the lathe-bed 20 feet wide, if the resistance was in the centre and the driving-power at the front, the slide could not be moved by any force; with the V at the back it would be scarcely better; but with the single V at the front it could be made to work. If these are the results in an exaggerated case, that which is bad in the extreme cannot very well be the best in practice. That arrangement of guide which would find the least would last the longest, and adding to the wearing surface by doubling the length gives a guide that will resist the twisting strain four times as long as the short one, besides protecting the ways from dirt and cuttings very much better than the short ones. Our arrangement of oil chambers in the body of the rest not only secures complete lubrication, but the oil tends to wash out the dirt and grit rather than wash it in, as is the case in the old practice.

Communicating the rotary motion of the lead screw, if that is used for the trundling-rod also, seems to be done as cheaply in the Pratt & Whitney lathe as any. A worm and worm-wheel, pinion and rack, seem to be the fewest parts possible, and with the friction device for starting and stopping the feed, the action is instantaneous. The objection to using a screw for a feed is not only the wearing of the screw out of pitch, but the loss of time in waiting for the screw to take up slack motion. There should be an arrangement so that the feed devie ccannot be set in motion while the screw is used for screw-cutting, and also conversely such an arrangement that the nut cannot be closed on the screw while the feed is in gear. I cannot conceive it possible to make a better device for opening and closing the two halves of the open nut than the two eccentrics on a rock-shaft. The eccentrics set opposite and set so they are about on the dead centre when closed, the rock-shaft operated by a handle, the weight of the handle serving to hold the nut closed when closed, and open when open. As it has been found that both the lead-screws and the nuts wear out badly in cutting screws, it is pretty safe to conclude that as made they are not half long enough. Let us guess the nuts ought to be eight or ten diameters in length, instead of four, and try that a few years, and see if they do not do better. If they prove so, then the second Rankine, or some one else, will put in his book that they ought to be so made.

As to the wearing of the lead-screws out of pitch, this occurs from the fact that the screw is in ordinary practice used a great deal more in one part of the lathe than others. The only remedy I know of being carried out to help this is in the Ferris & Miles lathes, where they make the lead screw reversible, so that when one end is worn they can change it. If a user of their lathe should use proper care, he might maintain a reliable screw for a long time. By always using the screw one end for cutting standard lead screws, and the other end for indifferent work, it would then maintain its truth much longer. Were it possible to determine in advance the relative proportion of times a screw is used along the different portions of its entire length, then a method could be adopted that would maintain uniformity of wear. If a lathe were used only a twentieth part as much at the foot-stock end as at the head, then cutting out nine out of every ten of the threads on the screw at the foot-stock end, and so proportionately eight out of nine, seven out of eight, six out of seven, &c., down to one out of two, perhaps, bringing the wearing area of the threads into some sort of proportion with the wear that comes upon them, then there would be at least a greater uniformity maintained than at present, if not an absolutely perfect one. But it takes a good deal of courage or faith, or something, that but few men possess, to put a nicely finished perfect screw in a lathe, and turn off two-thirds or three-quarters of the thread, and convince one's self, or other people, at least, that one is doing a good thing.

The shoulders or collars on the screw should both be at one end, then expansion will not make it bind, as would be the case if held by a shoulder at each end, or loose, as would be the case with outside collars.

For the cross-slide, very many builders use a short block working on a long guide. This seems to me to be anything but good practice. It does not take long for the guide to wear, so the block will be a loose fit at one point and a tight one at others, and the grit that is always accumulating on the exposed surfaces, helps this wearing business immensely.

Wm. Sellers & Co. reverse the order of things and run the long part over a short one, thus protecting the wearing surfaces completely. This brings the sliding part of the cross-feed and screw-handles a good way out in front of the lathe, but the objections to that may be imaginary.

My opinion is, that the guide extending entirely across the slide-rest and the sliding-block extending completely across also, are the right things so far, but there are many things to be taken into consideration. Other things being equal, that lathe would be thought the best which would turn the largest cylinder. But to extend the sliding-block completely across the lathe, that part in front of the tool-post need not be over one-quarter or three-eighths of an inch thick, so the swing of the lathe would not be reduced very materially. To use the equal length sliding-surfaces and not have the screw-handle project an inconvenient distance in front of the right and left hand screw for the cross-feed, meets the requirements.

(*To be continued.*)

STANLEY'S GREAT EXPLORATION.

Another geographical problem, and one of the most important which Africa has held in her grim keeping, has been triumphantly solved. There were good grounds for the belief that Mr. Stanley, with the advantage of his years of experience as an explorer, his vigorous and thoroughly acclimated frame, his combined courage and quickness of decision in situations of peril, and his exceptionally complete equipment for the undertaking, would succeed in reaching the western coast *somewhere;* but that he should have been allowed by fate to follow the Lualaba of Livingstone until it became the Congo, and to locate its entire course from the Manyuema country to the Atlantic Ocean, is one of the most signal successes in the annals of geographical discovery.

Stanley's last letters to *The Herald* before setting out on this wonderful journey, were written from Ujiji, on Lake Tanganyika, in August, 1876, and did not reach their destination until the 13th of last March. He announced his speedy departure for Nyangwe, on the Lualaba, the point beyond which both Livingstone and Cameron found it impossible to proceed. The difficulties encountered by the latter in his endeavors to reach the river from points further west gave us, in advance, a clear conception of the hazardous task which awaited Stanley. When these last messages arrived, six months of his unknown journey had already elapsed, and six more have passed before the news of his safe arrival at Emboma, on the Lower Congo, comes to relieve the general anxiety in regard to his fate, before it has taken the form of a painful suspense. Reaching Emboma on the 8th of August, his travels from Lake Tanganyika to the mouth of the Congo, must have occupied about eleven months, nine of which were spent in traversing territory utterly unknown.

The first report, which *The Herald* has just received, gives a general and somewhat vague geographical outline of the route. Stanley started from Nyangwe, the initial point of exploration, on the 15th of last November. Instead of embarking on the Lualaba, he appears to have pressed forward along the right bank of the river, carrying his supplies and the sections of his boat on the shoulders of men. His progress was greatly impeded by great tracts of dense forest, and the attacks of the savage native tribes, with whom he found it impossible to establish any friendly intercourse. He then crossed the river, and continued his march along the left bank, encountering the same obstacles. Finally the porters from Nyangwe, 140 in number, became so intimidated by the dangers which beset the party, that they deserted in a body. The march, in fact, was necessarily made in military order, with skirmishers in advance, and a rear guard. Many men were struck down by the arrows of the natives, shot at them out of the ambush of the forests. The desertion of the porters was followed by a combined attempt to extricate the rest of the party, and Stanley was finally compelled to betake himself to the river.

The brief sketch of the voyage will excite a general impatience for fuller details. The great stream flowed northward to the Equator, where its course was interrupted by a succession of cataracts. Stanley, who found that in spite of the hostility of the tribes on both shores, he was better able to protect his men in their canoes than in the forests, was obliged to cut a track thirteen miles in length, in order to transport his boat and the canoes below the falls. Then, after a period of very necessary rest, the voyage was resumed. On reaching the parallel of 2° north latitude, the course of the river turned westward, and then southwestward, in a great curve. It was from two to ten miles in breadth, and filled with islands, between which the little flotilla pushed forward with less danger from the attacks of the savages. All efforts to communicate with the latter failed; the supplies came to an end, and the party was threatened with starvation. Finally, when three entire days had been passed without food, Stanley halted at a village on the left bank, where, by a providential chance, the people were friendly, and had some intercourse with the sea-coast. They called the river "Ikuta ya Congo." From that point the name of Lualaba was replaced by "Kwango," or "Zoure" (Zaire ?)

Rested and amply supplied, the expedition set forth again. But its dangers were not yet over; in three days Stanley entered the dominions of a powerful tribe, the men of which were armed with muskets. They put off in fifty-four large canoes to attack the nineteen canoes of the intruders, and a desperate running fight was kept up for twelve miles down the river. This was the last but one of thirty-two separate attacks made upon the expedition after leaving Nyangwe. Of the force of 350 men with which Stanley left Zanzibar, in November, 1874, 115 survivors, in a miserable state of exhaustion, arrived with him at Emboma. His greatest loss was that of his only English assistant, Francis Pocock, who was carried over one of the cateracts of the Congo on the 3d of June last. A special fortune seems to have attended the explorer, for his own boat, the "Lady Alice," with himself and crew, was carried over another cataract six weeks later, all escaping as if by miracle. From Emboma there is easy communication with St. Paul de Loanda, and Stanley may, therefore, reach England in another month.

The exploration, it will be seen, beginning at the point where Livingstone and Cameron were interrupted, determines the entire course of the Congo river. But farther, through the great curve of that river beyond the Equator, it carries our line of knowledge over nearly half the unexplored region of Central Africa. Even if there are no great northern affluents of the Congo, as there are southern, we may consider it as now nearly established as settled facts, that the largest feeders of the Victoria N'yanza are the sole sources of the Nile; that the river Welle, of Schweinfurth, belongs either to the Schary, which flows into Lake Tsad, or the Benue, which is the main arm of the Niger; that the Ogowè, at present the favorite field of French explorers, has no important region of its own; in short, that no other large river-system will be found in the yet unknown region lying between the systems of the Nile, the Niger and the Congo. The results of Mr. Stanley's discoveries thus extend widely beyond their field. His good fortune has been commensurate with his daring and endurance; and the two journals which equipped him so liberally for the great venture are rewarded by a contribution to geographical knowledge, which has never been equalled by any single journey of exploration. When we take Stanley's new source from Zanzibar (or, at least, from Ugogo) to the Victoria Lake, including the discovery of the Shimeyu River; his complete circumnavigation of the lake; his examination of the southern end of Albert Lake; his journey from Karagwe to Ujiji by a new route; his repetition of the complete survey of Lake Tanganyika; and finally, his marvellous descent of the Lualaba-Congo to the Western Ocean, we must admit that it stands alone, in variety and importance of achievement, in the records of African travel.—*N. Y. Tribune.*

BRACKELL'S PUMPING ENGINE AND BLOWER.

The cuts, (Levytyped from *The Engineer*, xliv, 106,) show a device designed for a pump, blower or air compressor, designed by Mr. C. Brackell. The device is claimed to produce blast from a few ounces to 100 lbs. per square inch,or a vacuum up to 12 lbs. One of 36 inch cylinder, used in 36 lb. blast was run at 180 revolutions per minute without being bolted down; and when run at 80 revolutions per minute was stated to be equal in capacity to an ordinary blowing engine 26x3 feet, although only 5x3 feet on the ground.

The steam and blowing cylinders are end to end; a shaft running through both bears two oscillating pistons. The steam cylinder has a fixed abutment; the steam is admitted on each side of the piston, alternately, by a slide-valve, whose spindle forms a small piston at each end, working in cylinders in the valve chest. A small finger valve (worked by a lever and by a cam on the main shaft,) admits steam to each valve piston, alternately. This arrangement enables the blower to be run at a great range of speed, especially as the valve pistons have steam-buffers.

The blower-chamber is shown in Fig. 5, with piston in vertical position.

Fig. 2 shows a vertical arrangement of engine and blower.

Figs. 3, 4 and 5 show different arrangements for driving the blowers, by belt, gearing or hand. G.

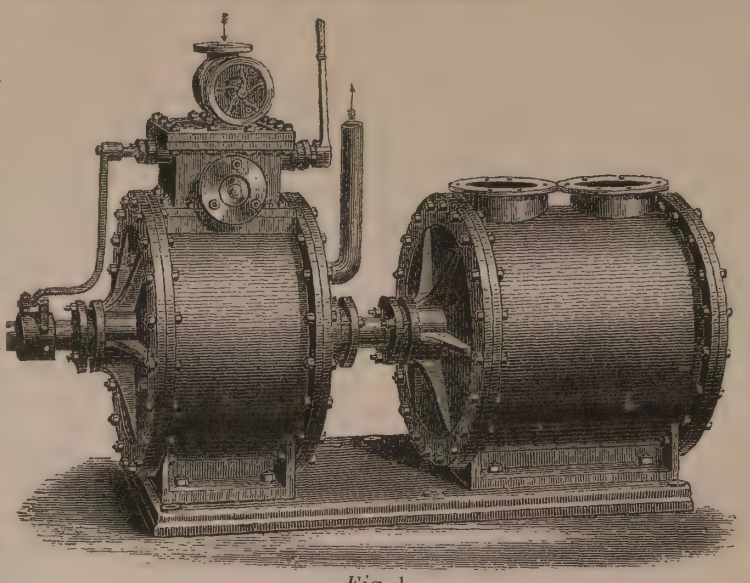


Fig. 1.

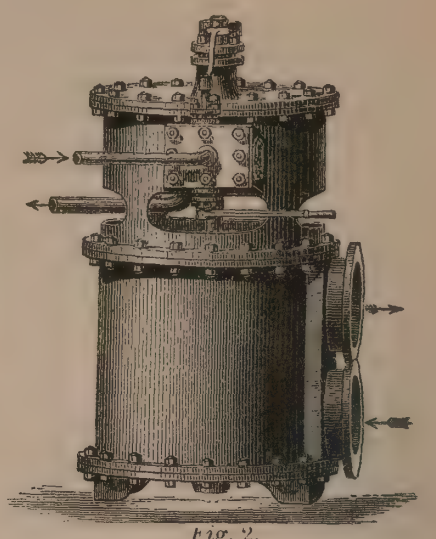


Fig. 2.

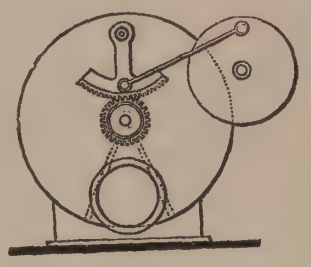


Fig. 3.

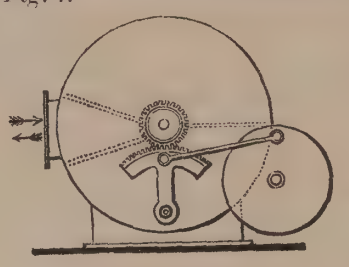


Fig. 4.

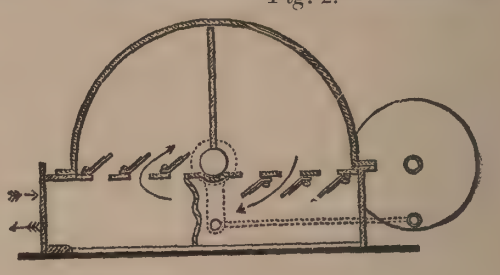


Fig. 5.

THE UTILIZATION OF ANTHRACITE WASTE OR "CULM."*

This subject is one of very considerable interest,and as made known in this Journal of the 22nd ult., the manufacture in this country is now a decided success. In order more fully to be able to lay the facts in the case before our readers, we visited the the works of the American Fuel Company, on Wednesday last. The works are situated on the Hudson River, at Port Ewen, Ulster county, one mile below the mouth of Rondout Creek, and occupy the site formerly used by the Pennsylvania Coal Compay. The main dock occupied by the Fuel Company is six hundred feet long by one hundred and ten feet wide, and being surrounded by water, a frontage of nearly fifteen hundred feet dock room is available. The "plant" consists, in addition to the dock and shipping facilities, of buildings for the raw materials, engine and boiler houses, and a double system of machinery for production.

The process of manipulation and manufacture is brief and simple, being pretty near automatic. The coal dust is brought in boats via the Delaware and Hudson Canal, from Honesdale, where it is received from the mines. The small quantity made at Rondout in the screening, of coal on the docks is also made available.

The cargoes of "Culm" as the coal dust is technically called, are brought directly under the Company's elevator, on the river side of the dock. This elevator carries it to a height of sixty feet, where it is distributed by chutes to the proper bins; it is said to cost but three cent a ton to put it from the boat into the bins. The capacity is thirty tons per hour. The culm receivers have capacity of 260 tons each. Between the two culm receivers, is the "pitch" receiver, which holds the material used in fusion with the dust. This compartment has a capacity of 140 tons.

No previous preparation is necessary for the raw materials under the American Fuel Co. process, than the reduction of the pitch to a state of fineness equal to that of pea coal and smaller. This is done by a system of crushers, having prism shaped teeth; it being a peculiarity of this eccentric material that disintegrate under concussion, even when too plastic to resist heavy pressure. When it has passed the second crushing an elevator distributes it right and left into large funnel shaped receivers. Here it is promptly taken off by automatic "feeds," as, if allowed to stand any length of time, it will solidify, under either pressure or a higher temperature. The pitch itself is a manufactured article, being the severe distillation of coal tar. In other words, it is the bitumen of soft coal. The average proportion of pitch used is ten per cent.

The culm having passed down through a chute at the bottom of each receiver, is fed automatically into a screw conveyor, which moves it forward to the point of its union with the pitch. The exact proportion of the pitch is regulated by an ingenious feed arrangement so adjusted that no matter what speed of production is obtained, the proper proportion will be preserved. The pitch and culm come together at the inner end of a dry mixer, and are thoroughly mixed in that state before fusion. The material is then elevated into the fusing cylinder, the bottom of which, in position, covers a segment of of the moulding table. In the center of the machine room, between the two systems, is an upright tubular boiler, the steam which is conveyed into a dryer on top, where its temperature is increased to 375 or 400 degrees, and it is then passed through a superheater, where it is heated up to 575 or 600 degrees. It is then distributed by pipes to the fusing cylinder, where through heavy cast iron nipples, controlled by valves specially constructed of steel to resist the severe effects of very hot steam, it is applied to the materials, the result being the complete liquefaction of the pitch, and its thorough fusion with and absorption by the coal dust. At the bottom of the mixer the material is forced into the pockets of the mold table, a large horizontal wheel, moving at the speed of about 2½ revolutions per minute, and containing ten molds or pockets, 6 x 10 x 4½ inches, at the bottom of each of which is a moving piston or "plunger." As the molds are filled the pistons pass over a movable incline, resting on a lever which runs through to the center of the machine, and held in suspension by a heavy rod which is itself held at the top of the machine by four heavy rubber springs, thus securing a system of adjustable pressure; for no matter what the consistency of the material these springs will yield to the point desired to allow the passage of the pistons. A pressure of thirty thousand pounds is thus safely secured. As the pistons pass over the incline they press upward against the pressure plate, the wearing surface of which is lined with the finest steel.

The operation of filling the molds with the preparation and its subsequent pressing is continuous. As the molds emerge from under the pressure plate, the pistons move up another incline by which the blocks of coal are brought flush with the surface of the molding table, whence they are swept to a carrier, composed of an endless positive transmission chain. This carrier, sixty-five feet long, delivers the blocks in regular order at the side of the dock, where it falls into the hands of men, four in each belt, who at once stow it, in regular tiers on board the boats. The blocks of coal are brick shaped, weigh about 14 lbs. each, and are hard enough to handle and stow when they emerge from the table.

The motive power of the works is a 200 horse-power Corliss engine of the condensing pattern. The cylinder is 20x48, with four foot stroke, the fly-wheel is sixteen feet in diameter, and the engine connects with the main shafting by three gears, of five and a half feet in diameter each. Less than half the power of this engine is required for present uses. Facing the engine is the boiler house, at the other side of the dock; it contains two tubular boilers, 6 x 16 feet each, with 60 four inch tubes. The boilers are 100 horse-power each. They drive the engine for present work with an average of 42lbs. pressure. The Company invites special attention to the completeness of their supply of steam.

These works were erected in the winter and spring of 1876, but a quantity of the material had been made in July 1875, and submitted to very severe tests on the locomotives of the Philadelphia and Reading Railroad Company, where the success of the processes became assured.

The product is sold in competition with Semi-Bituminous coal, as a steam-raising fuel in locomotives. The Company has already contracted with several roads for either the whole or portion of their fuel supply, the amount being forty thousand tons for this year. As the patent fuel is becoming more widely known and appreciated, the sales will no doubt increase, and as the works are laid out the system is capable of enlargement to any extent, upon the grounds already occupied. The patent fuel stows about three-fourths the space of other fuel, compared by weight. Its evaporative power has been shown to equal eight pounds of water to a pound of fuel; the ash ranges from six to nine per cent according to the quality and hardness of the "culm' before mixing. thus cleaning it of all earthy matter.

It is said that no clinker results from the combustion of this fuel, and clean fires and a regular head of steam are the rules of its practical use. We feel sure that the course of this enterprise will be regarded with great interest, for anything tending to the utilization of what is now waste, is of value; truly so, when we consider that the amount of Anthracite coal sent to market represents but about four-fifths of the quantity that is actually raised from the earth; the balance being piled up in unsightly heaps. Although the manipulation of over one hundred thousand tons of this "culm" by the American Fuel Company might be possible, it would not perhaps affect the market price of anthracite coal; but it forms an important item in the fuel supply of the seaboard, and there could be other organizations with the same object in view. So that in the not distant future, when we reach the maximum possible annual production of Anthracite, with an increasing demand it will be very useful to know by what means the slack or waste "Culm" can be made into a marketable product; this may be the means of preventing prices from going into extravagant ranges.

*Saward's Coal Trade Journal.

THE BREAD AND BUTTER OF PLANTS.

Roughly speaking, the composition of all plants may be divided into three classes of substances:

1. Water—drawn off at 212° F.
2. Organic substances—burned off on ignition to redness.
3. Ash—fixed at a red-heat.

The average composition of all grasses, grains and seeds, straw and chaff and hulls is, when air-dried—

Water,	14 per cent. to 15 per cent.
Organic Matter,	78 per cent. to 83 per cent.
Ash,	2.5 per cent. to 8 per cent.

Roots and tubers have, as their composition—

Water, 85 per cent., Organic matter, 13. to 14 per cent., Ash, 1 per cent.

Of the complex and numberless substances grouped under the comprehensive title "Organic Matter," but comparatively little is known. The field is so vast, and the number so infinite, that in a larger number of cases the mere existence of these only, without any of their properties, is known to us, and, in many cases, doubtless, compounds have passed examination without being detected at all, on account of our having no known method of separation. Suffice it to say, that all of these organic bodies, even when having the most widely different characteristics, are composed of nearly the same elements, and that the sweet scent of the rose varies from the rank poison of the nightshade, only in the arrangement of them.

The carbon is derived from the carbonic acid of the atmosphere; the hydrogen and oxygen from the moisture of the same, (rain), possibly to a certain extent from other sources. The nitrogen is assimilated from the air, also through the roots taken up in the form af ammonia or nitric acid, but never in the form of free nitrogen, as has been demonstrated by experiments. But how these elements unite together and build up the various vegetable compounds of the plants is a question still unsolved. All that that we can say positively is, that it is through the united effects of the heat and light of the sun, of some unknown action, of the green coloring matter of the leaves, (*chlorophyll*), and to that agency known to us as the "life" of the plants.

Regarding the *ash*—mineral matter derived from the soil—we are not quite so much in the dark. Anything absorbed by the plants, through the *roots*, can be experimented with, both on the small and large scale, which is not the case with the leaves on the large scale, as we cannot fix or alter the composition of the ever-moving atmosphere.

Of the score of mineral elements found in the ash, the most valuable to the plant are phosphoric acid, potash and lime. In addition to these, ammonia, which is also taken up through the roots, but is not found in the ash, being volatilized in the ignition, is of equal importance.

In order to supply the plant with the above substances, an immense industry has sprung up in the manufacture of *fertilizers*. Both in this country and in England, France and Germany, millions of capital are invested, and hundreds of thousands of tons of super-phosphates and other fertilizers are manufactured annually. In the season 1876-'77, there were 75,824 tons inspected for the market in Georgia alone, as is shown by the official report of the Commissioner of Agriculture of that State for the present year; and yet the general testimony is that much more could have been sold there if the manufacturers could have supplied it. The *average* cash price for all fertilizers in that market for the last three years is $43.70 per ton; and yet those who have made most money in this industry have, without doubt, been the farmers, from the increase in crops. A more difficult class of people to introduce anything new amongst, cannot be imagined; and, therefore, the rapid growth of that business in the last ten or fifteen years, is a solid proof of the real value of these artificial manures in forcing plant growth.

To give an example, it is the custom of the Department of Agriculture, in various States, to have samples of fertilizers sold therein, sent out not only for analysis, but also for actual "soil tests," to a number of the most prominent farmers. From a pamphlet before me, describing the results of these tests, in the year 1876, in Georgia, on cotton, is taken the following set of figures:

"Soil *without* fertilizers—61¼, 78¼, 87½ lbs. seed cotton per acre, (three different rows not fertilized.)

"Same soil, *with* fertilizers, (three brands)—656 lbs., 691 lbs., 630 lbs. seed cotton per acre.

Again—Without fertilizer—161 lbs. seed cotton per acre.

With	"	700	"	"
Without	"	490	"	"
With	"	4,050	"	"

And so on, for several hundred examples, cotton being the most important agricultural production of the State. With other plants it is just the same, the yield being increased, frequently, several hundred per cent. by the application of phosphoric acid, potash or ammonia, or of all three of them, as the case may be. A very large number of these "soil tests" have been made both in France and in Germany. The United States, in comparison, is far behindhand. It has been only within the last two years that the above mentioned agricultural "stations" have been established in this country. Before that time the most gigantic frauds were practiced upon the unhappy farmers—fertilizers being sold them, composed largely of ground dirt and coal ashes, with some decomposing organic matter to give the orthodox smell, at prices varying from fifty to seventy dollars per ton. A certain volume has been published, giving an *expose* of the extent of these frauds. The edition was quickly bought up by the manufacturers, and the book suppressed; the whole thing causing a considerable amount of excitement at the time, as a great many of the most prominent manufacturers, including a number of this city, were thus "shown up." All this, however, is now a thing of the past. Many of our States, both in New England and in the South, have enacted the law that no fertilizers shall be sold therein unless the analysis, made by the chemist of the agricultural "station," is printed on every bag.

The whole subject has now reached the position of a distinct science. The action of each ingredient, upon nearly every plant, has been carefully worked out by a large number of practical experiments, so that we know which crops need ammonia, which need potash, which phosphoric acid, &c. So far as the composition of the fertilizer is composed, the farmer knows exactly what to buy. Two other important elements in the cultivation, however, which frequently produce confusion and doubt in drawing the conclusions from experiments, have to be determined in each separate case. The nature of the soil and of the climate; also, of course, the skill and experience of the farmer in the management of his crops is of no small importance. But the practical result is that by the use of a fertilizer, he always gains, whether this gain be moderate or large, depending upon his skill and judgment in selecting the proper food for his plants.

The strength of the South now, and the key to its future success, is, without doubt, the fertility of the soil and the abundance of the crops. It is equally sure that its present curse is found in the person of the carpet-bagger and the politician. So that this state of affairs illustrates in the most remarkable manner the truth of a well-known observation of Dean Swift. Said the author of "Gulliver's Travels," "And he gave it for his opinion, that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together."

HENRY PEMBERTON, JR.

ROOM FOR INVENTION.

We frequently hear the remark that the time will soon come, when the course of invention will be run; when, like Alexander, inventive genius will weep because there are no more worlds to conquer. The fact that iron fingers have in so many branches of industry been made to perform tasks once done by bone and sinew; that electric throbbings have outstripped the fleet messenger in business affairs, and the iron horse with food of burning coals carries the love-letter and the meal-sack, where once the oat-fed country steed galloped along the hard-beaten road—these facts are impressive and suggestive, but not convincing on the subject of an ultimate limit to inventive usefulness or inventive power. The ball of progress in rolling along has wrapped about it many a layer of ideas formed into tangible facts; but the periphery grows, and the capacity for enlargement grows with it. As the circle of knowledge widens, the illimitable space beyond still more increases, and there is both more to learn, and greater ability to learn it. If the needs of man were the sole gauge of his demands, there might well be a point at which invention, satisfied with granting all needful things, would be compelled to rest. But "to want" means both "to lack" and "to desire;" the food and shelter and clothing absolutely requisite develop into luxuries of palate and æsthetic taste. The rude needle of bone that sewed with sinew the boar-skin cloak and made of it a definite garment, was an invention that might have sufficed in its line, had the skin-garment satisfied; but demand and supply are commensurately progressive; each surpasses each, onward in the march of progress; and now we have that household companion the sewing-machine, purring like kitten, while basting, sewing, hemming, gathering, tidily at high speed;—this modern sewing machine being as legitimately the development of the bone needle as the fashionable garment of to-day is the outgrowth of the fig leaf of Eve and the skin covering of her sons.

Our wants have become artificial; with successive generations, luxuries develop into customary grants and eventually become necessities. Our condition is ameliorated, and hence our appreciation sharpened, while certain faculties have become dulled and invention must supply their places or their deficiences. Where invention has produced an effect, it is for invention to extend and perfect it. Thus in every walk of life it is for cunning brain and deft fingers to effect new combinations or perfect the old, fearless of thwart or limit. In proof that with improvement criticism becomes more keen, and demands more imperative, we have only to look about us for promising fields to engage the inventor. While the harvest of golden grain no longer falls before the classic sickle, and the haymaker has ceased to be a picturesque inspiration for the poet—the root-crops still demand personal delving and grubbing, and the ripened fruits still call for human pickers to pluck them one by one. For the inventor who would devise a mode of removing half the blossoms from a peach tree, without injuring the buds which form the next year's bearing stems, there awaits a magnificent prize. Ramié and other fibers still defy the texile art; and the gorgeous aniline dyes fade with a summer's sun. Household fires, once synonyms of health and cheefulness, are now gloomy and noxious monuments of our heedlessness of things sanitary. Those domestic conveniences that should minister to our comfort and well-being, poison us insidiously but surely. Our vaunted gas-lights blacken our paint and kill our window plants, while in the street, the pipes which lead the gas destroy our shade trees. Our sewers and our drains are confounded in name and in use, and both of them are poisonous. Our chimneys breathe forth smoke which is unconsumed fuel, and hence wasteful. Our steam-boilers, with partly consumed fuel, supply our engines with wet steam, and the engines (whose cylinders have to be supplied with oil, through faulty design and workmanship) waste part of the remainder. Our horses, shod with no regard for humanity or for tractive effect, draw wagons or cars which rattle our teeth out, on roads or rails which rattle the vehicles to pieces. The explosives which long ago were constrained to throw hurtful missiles for miles, have but in one instance—blasting—been employed in peaceful work; if we may except the gun-powder pile driver, the precursor of a long line of explosive motors yet to come. There is yet no ice-machine which will satisfactorily and economically compete with nature in supplying a commodity now so great a necessity. The science of aëronautics to which the veteran Wise and others have devoted so much time and skill, and which they have demonstrated to be far within the bounds of safety—has not been developed from flotation to guidance—still less to propulsion. A spark of fire has terrors greater far than those of the avalanche or the glacier.

For these and hundreds of other evils, inventive genius must provide the remedy; and as new and artificial wants arise and develop into necessities. upon the inventor, ever in the van-guard, devolves the duty of exploring the land of the possible and providing for the legions of the actual.

It might be said that as science after science falls into the ranks of knowledge, and art after art is added to the forces of man, the field of true invention would narrow, and that of improvement, combination and application correspondingly widen. And this distinction may not perhaps be improper to draw, nor inappropriate to apply. Certain it is, that as observation and experience lay down the facts, and reason deduces therefrom the theories and evolves from these again the laws which govern things tangible and forces intangible, the plane of the inventor will rise higher and higher, and his usefulness will never diminish. It is to him that races unborn, nations unformed, countries unexplored, look for their betterment and the achievement of their substantial welfare. Through him the antagonism between man and man—the foul distinctions of caste and class—will be swept away; and better men, under better lives and higher pleasures and comforts, achieve the destiny written for them in the days when the rocky ribs of this earth were formed.

G.

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SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

SECOND PART—§ VI.

THE GOOCH LINK-MOTION.

This link-motion was invented independently of and almost simultaneously with the Stephenson link-motion, and is distinguished from the latter principally in that the link is suspended at a stationary hight, the link-block being moved instead, by the reversing lever, as illustrated in Fig. 53. The

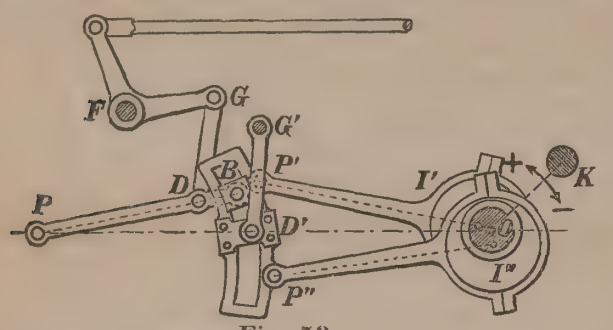


Fig. 53.

connection between the link block and the valve stem is effected by the radius rod *BP*.

To investigate the theory of this link-motion, let us again neglect the influences of the oscillation of the several members, and consider the movement of the pins *P'* and *P''* to be strictly horizontal. The centre line of this link-motion is the line passing through the crank-shaft *O* and the pin *P* of the valve stem. The movement of the chord *P'P''* of the link is now precisely the same as that of the shifting link when in mid-gear. Supposing that *I'* and *I''* (Fig. 54) were the eccentrics, and

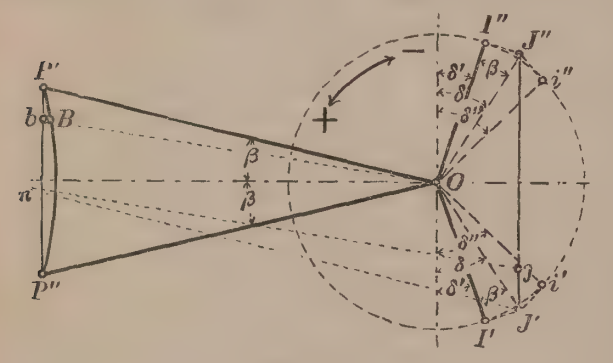


Fig. 54.

P'P'' the link in its neutral position, we can find the ideal eccentrics *J'* and *J''* of the movements of the pins *P'* and *P''*, by moving the real eccentrics *I'* and *I''* through the same angle (*β* and the same direction as the corresponding eccentric rods would have to be moved to make them horizontal, and then drawing the lines *I'J'* and *I''J''* at right angles to *OJ'* and *OJ''*.

The horizontal movement of any intermediate point, *b*, of the chord of the link can again be shown to be equal to the horizontal movement of a corresponding point *j* of the line *J'J''*, in the same way as before (see Fig. 31); and since in this link-motion the movement of this point is directly transmitted to the valve when the link block is raised to the point *B* (the movement of the points *B* and *b* being practically equivalent,) the point *j* is the ideal eccentric of the movement of the valve, and the ideal eccentric for any other grade is situated in the straight line *J'J''*, dividing it in the same proportion as the position of the link-block divides the chord of the link. The relation existing between the points *b* and *j* can again be established by parallel lines. Draw a line through *J'* parallel to *O P'* and extend it to its junction, at *n*, with the horizontal centre line. The line joining *j* and *n* will then be parallel to that joining *O* and *b*. The valve diagram, Fig. 55, can now

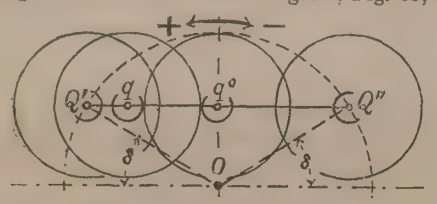


Fig. 55.

readily be drawn, showing the lead of this link-motion to be equal throughout all grades. In other respects, the feature of the variableness of the expansion and the exhaust is very much like that of the Stephenson link-motion.

The curvature of the link, having its convex side turned towards the crank-shaft *Q*, should have a radius equal to the length of the rod *BP* (Fig. 53) as will be seen by setting the link in its neutral position, where a lowering or raising of the link-block must not produce a movement of the valve. The link is mostly suspended, having its centre in the centre line.

If crossed eccentric rods are employed, the eccentrics should have the positions *i'* and *i''* (Fig. 54), when the corresponding eccentrics will again be represented by *J'* and *J''*, and the diagram of the ideal eccentrics will be identical with the one for open rods.

To reduce the slip to a minimum both suspension rods *GD* and *G'D'* (Fig. 53) should be vertical when in their neutral position. To this end the point G should be guided in an arc equivalent to the arc made by the point *D* when the link is in its neutral position. The fulcrum *F* should, therefore, be vertically above the neutral position of the pin *P*, at a height equal to the length of the hanger, *GD*; and the length of the lever *FG* should be equal to the length *PD*. In practice, however, this lever is usually made shorter, and is located to effect a rectification of the cutting off fore and return strokes.

The advantage of this link-motion over the one treated before consists in the permanency of the lead throughout all grades, while the increased number of parts, the less length that can be given to the eccentric rods at a given distance of the crank-shaft from the valve-chest, and the greater side pressure that the valve-stem receives from the inclined rod, involving the necessity of a guide for the valve-stem, are doubtless disadvantages.

Problem X.—A Gooch link-motion shall be designed to cut-off, when in full gear, at three quarter stroke, and to cushion for one-twelfth of the stroke. The greatest port-opening is required to be $1\frac{1}{8}''$ with a lead of $\frac{1}{8}''$. The link is 12″ long and the eccentric rods are 2′, $1\frac{1}{2}''$ from centre to centre. It is required to draw the valve diagram and to find the throw and position of the eccentrics for both open and crossed rods.

The centres *Q'* and *Q''* (Fig. 55,) for the full gears can again be found as usual, the construction yielding an outside lap $=1''$, an inside lap $=\frac{1}{16}''$ and the travel of the valve $=4\frac{1}{4}''$. To find the required throw and position of the eccentrics we draw the link in its neutral position (see Fig. 54), to find the angle *β*, carry the same to both sides of the lines *OJ'* and *OJ''* (*J'* and *J''* to correspond with the points *Q'* and *Q'* of the valve diagram, Fig. 55), and draw the lines *J'i'*, *J''i*, *J''I''* and *J''i''* at right angles to *OI' Oi'*, *OI'' Oi''*, respectively. The points *I'* and *I''* represent the required eccentrics if open eccentric rods are used, and *i'* and *i'* those for crossed rods. The throw of the eccentrics can be measured by the lines *OI'*, etc., and is found $=2\frac{1}{16}''$. The angular positions of the eccentrics are given either by the angles *δ'* or *δ''*. Both eccentric will then have an angle of advance $=\delta$ in relation to their eccentric rods.

The proper points of the link producing certain grades of cut-off can easily be found by the use of the valve diagram.

A rectification of the cut-off of four grades can be accomplished, as in the Stephenson link-motion, through the oscillation of the link and the movement of the hanger *GD*. The stationary hanger *GD'* cannot be made available for this purpose, and should, as a rule, be suspended vertically, in its neutral position, except if the foward grades are to be favored at the expense of the backward grades; for the rectification of the backward grades will call for exactly the opposite inclination as the rectification of the foward grades. A paper model (see Fig. 56,) can again be used to find the suitable position of the

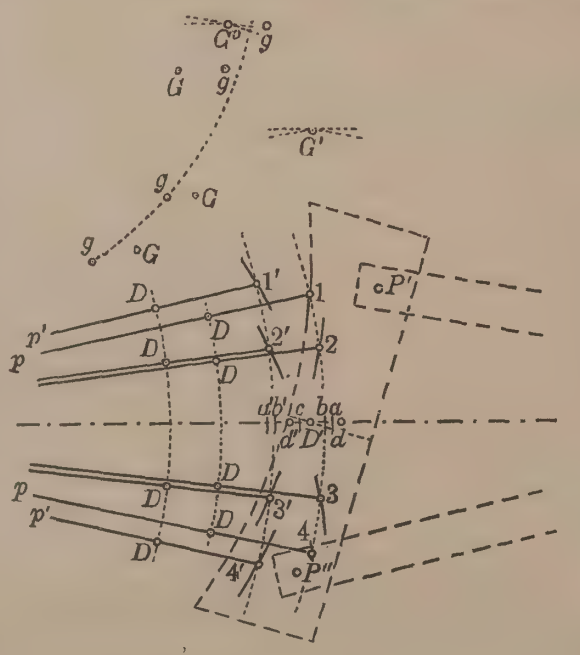


Fig. 56.

stud *D* and the suspension lever *FG*. After drawing the orbit of the eccentrics, and the crank-angles for the cutting-off of the four grades, we desire to equalize (compare Fig. 50), we attach the link to correspond with the dead centres of the crank, mark the points *a* and *a'* (Fig. 56), bisect their distance in *c* and mark the points *b* and *b'* representing the position of the link-block (in mid-gear) when the cutting-off takes place. Then we sweep the paths, through *b* and *b'*, of the link-block when raised or lowered for the said positions of the valve. Next we assume, at pleasure, a point of the link, say *D'* (Fig. 56) for the suspension pin, and make $ad = a'd' = mD'$, in order to locate the suspension fulcrum *G'* by sweeping two arcs from *d* and *d'*, of a radius equal to the length of the hanger *G'D'*. This being done we set the link for the crank-angle 1, adjusting the point *D'* of the link to the proper distance from G′ and mark the intersection 1 of the link-curve with the arc *b*. We repeat this for the crank-angle 1′, marking the point 1′ on the line b'_0, and continue with the other crank-angles to obtain the points 2, 2′, etc. Draw the corresponding positions of the valve-rod 1*p*, 1′*p'*, etc. (the points *p* and *p'*, towards which the two sets of lines converge, are not shown on the drawing), and mark the points *D*,*D*, of the suspension pin of that rod. Two arcs swept from the points *D*, of the lines 1*p*, and 1′*p'* locate by intersection the point G° from which the hanger of the valve-rod should be suspended for having the first grade rectified. The points of suspension *G*,*G*,*G*, for the other grades will be found by the same method.

But, whereas, these four points are not located so that one circular arc can pass through them, they do not suit our purpose. We have, therefore, to change the assumed position of the suspension pin *E'* of the link laterally, and to repeat the above operation until the suspension points can be connected by a circular arc, which then determines the length and position of the suspension lever.

In the case shown in Fig. 56 the suspension pin *D* would have to be on the other side of the centre line of the link to obtain this result and the location of the suspension lever would be very awkward. The stud *D* may, therefore, be located in the centre line of the link, when the points *gg* will be found and the suspension lever may be made to pass in their close proximity, as indicated by a dotted arc. It will now be noticed that this arc passes exactly through the points of suspension for the backward grades, but is less favorable for the forward grades. Since the reverse would be the more desirable, we may reverse the whole arrangement, *i.e.*, locate the suspension lever below the centre line of the link-motion. Or, if a reduction of the slip is more desirable, the valve may be made with unequal lap when the correction of the cutting-off can be conveniently accomplished with a minimum amount of slip, at the expense of the equality of the lead. Unequal lead is of very little consequence, because the position of the piston for the moment of the opening of the port will be scarcely affected by a slight change of the lead.

Another expedient, sometimes adopted to better equalize the distribution of Steam for the forward grades, at the expense of the backward grades, consists in suspending the link so that its centre is below (or above, as the case may require) the centre line of the link-motion.

(To be continued.)

Spoiling Mirrors.—It is a fact worth knowing, but which does not seem generally understood, that the amalgam of tinfoil with mercury which is spread on glass plates to make looking-glasses, is very readily crystalized by actinic solar rays. A mirror hung up where the sun can shine on it is usually spoiled; it takes a granulated appearance familiar to housekeepers, though they may not be acquainted with its cause. In such a state the article is nearly worthless; the continuity of its surface is destroyed, and it will not reflect outlines with any approach to precision. Care should therefore be exercised in hanging. If any of our readers have mirrors which appear to be spoiling, it would be well to ascertain whether the direct sunlight strikes them. If thus exposed, they can probably be saved from further injury by simply changing their position. The back as well as the front must be protected. A small glass hung in a window, where the rays strike it behind, is peculiarly exposed. The back should always be covered where the beams are likely to touch it.

The greatest danger to looking-glasses, however, is in transporting them. Very expensive ones have been seriously injured by careless handling when merely carried across a street. The men who move furniture are seldom fully aware of these possibilities, and need to be cautioned and watched. Frequently a man or boy may be seen in the street carrying a mirror in such a way that the full glare of noon-day strikes and injures it. Owners of such articles would, as a rule, be able to keep and use them much longer if they would exercise much caution in this regard. To re-silver a pier-glass often costs as much as one-fifth of the original price of the article; while the common glass is seldom worth re-silvering.

It is also well to avoid hanging a mirror near a stove or fireplace, where the heat radiated can reach it. If this precaution is neglected, granulation is likely to occur, even in a comparatively dark room, by the influence of warmth instead of light. A lamp or gas jet, if placed too close while burning, though it may not crack the glass, will often bring about the same injurious crystalization, and will even sometime cause the amalgam to melt and run off.—*Crockery and Glass Journal*, vi, 12.

The Eames Process at the steel works of Anderson & Passavant, Pittsburgh, is giving gratifying results. An 8-foot furnace is now in operation, and a 24-foot furnace is to be built. Strong iron has been puddled with 38 gallons of benzine, and "frozen" pots melted in a coke hole in 2 hours and 10 minutes with 17 gallons. The process is to be tried at some of the iron mills.—*C. Railway Rev.*, xv, 95.

PROGRESS IN SCIENCE AND THE ARTS.

☞ This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Illumination by Electric Light.—The application of electricity for lighting seems at last to have been accomplished. For some time the magneto-electric machine of Gramme have been used in the lighting of certain factories in Paris and its neighborhood, and the number goes on increasing; and where the ceilings are lofty and direct light applicable, the success is perfect. Among the establisments so lighted are those of Cail & Co., engineers; Sautter, Lamonnier & Co., the makers of the Gramme machines, both of Paris; and Thomas & Powell, or Rouen, and at the Fives-Lille Works.

The system of direct lighting, however, is not applicable to weaving or spinning sheds, the ceilings of which are low; the light is much too intense, and everything which impedes it—shafting, driving-bands, and machines—create intense black shadows. The problem was to get a light which, like that of the sun, allows objects to be seen by reflection; and this has been achieved by throwing the light, by means of a hyperbolic reflector, on the whitened ceilings and walls, when the machinery is sufficiently illuminated by reflection to cause everything to be seen as on a bright sunny day, while the eye is not fatigued, nothing is painfully brilliant, and nothing obscure.

The expense of the electric light is given as follows: The cost of a machine with lamp, giving light equal to 500 Carcel jets, is about $450, and this will represent from 50 to 70 gas jets, according to circumstances. The power required is equal to 2-horse steam power, and the cost of the carbon points, as already stated, is 4 cents per hour for each lamp. When the power is that of water the cost is inconsiderable, and when that of coal has to be taken into account for the steam-engine, it amounts to 4 cents per hour, bringing the total up to 8 cents per hour, and lubrication is set down at about ½ cent more, while the wear of the machinery is regarded as *nil*. Taking for basis that an electric lamp only replaces the minimum number of gas jets, namely, 50, it is 7 times cheaper than gas, motive power not included, and 4 times cheaper, taking the cost of driving as estimated above.

These facts compose a strong case, and the success which has been obtained is easily ascertained. A perfect light as regards colors, which neither injures the eyes of the workpeople nor renders factories unhealthy by contaminating the air, while immensely reducing the risk of fire, and which saves 75 per cent on the cost of gas lighting, possesses so many advantages that it is only surprising that manufacturers are not more eager to accept it at once.—*Manufacturer and Builder*, *ix*, 230.

The Prevention of Corrosion.—Prof. Barff lately read a paper "On the Formation of the Black Oxide of Iron or Iron Surfaces for the Prevention of Corrosion," before the British Association. The paper was very brief, but highly instructive, and was illustrated by various specimens of cast and other iron which had been experimented upon. At the commencement the Professor remarked that the decomposition of steel and iron by sufficiently high temperature had long been known to chemists, so that he could not lay claim to the discovery of it, although it had been attributed to him by some. The paper then proceeded to detail the experiments which the Professor had made for the prevention of corrosion by a steam superheater. One important result of the experiment was that different temperatures were found to have different effects upon the appearance of castings, a higher temperature producing a brighter surface. In conclusion, the Professor stated that he had several important experiments now in hand, but as yet he was unable to publish the results. The President of the section, Dr. Abel, read a note upon the same subject from Mr. Bower, which affirmed that, from the writer's experiments, he found that direct oxidation of the air produced in cast iron a coating which is equal to superheated steam. A brief discussion followed, in the course of which the President referred to the present method of protecting or coating gun barrels, and to the important results which Prof. Barff's experiments would probably ultimately have upon such methods.—*Mining and Scientific Press*, *xxxv*, 198.

In the Neighborhood of Baku, Transcaucasia, there seems to be an almost endless supply of napthha. In many cases, naphtha fountains rise in summer 100 ft., and the liquid mostly flows away unutilized, as these large quantities cannot be collected. In the year 1874 there were at Baku 180 works in action, many of the smaller of which, however, have been stopped under the pressure of competition of the American petroleum. With better means of transport the Baku petroleum could readily compete with the American product. The largest manufactories are at Surakh Khana, where the gases, streaming from the earth, are used as fuel.—*English Mechanic*, *xxvi*, 35.

Resin in Beeswax.—Beeswax has been of late frequently found adulterated with resin. The usual mode of detecting the fraud is to heat the product until it begins to smoke, when the smell of resin becomes distinctly perceptible. A more accurate method is proposed by E. Schmidt, which is claimed to rapidly show the presence of even relatively small proportions of resin. About one drachm of the wax is heated in a flask with four or five times its weight of ordinary nitric acid of sp. gr. 1·31 to 1·33, until it boils, and is kept boiling for a minute; then an equal volume of cold water is added, and lastly, enough of ammonia cautiously poured in to cause the liquid to smell strongly of the reagent. The alkaline liquid is now decanted from the precipitated wax into a cylindrical vessel, and its color observed. If the wax was pure, the liquor will have a yellow color, while if the resin was present, the liquor will have a more or less intense reddish-brown color, due to the formation of nitrous compounds. This being a colorimetric test, it is well to have some perfectly pure wax for comparison. If the wax contains resin, the reaction is much more violent during the boiling with the acid. As little as one per cent. is said to be detected in this manner.—*Druggists' Circular*, *xxi*, 166.

The Telephone Anticipated.—The telephone is commonly supposed to be an instrument of very modern invention, but in M. Le Comte du Moncel's "Expose des Applications de l'Electricite," published in 1857, it was very clearly suggested. It is there said:

"Imagine one speaks near a mobile plate, flexible enough not to lose any of the vibrations produced by the voice; that this plate establishes and interrupts successfully the communication with a battery. You may be able to have at a distance another plate which would execute at the same time the same vibrations. It is true that the intensity of the sounds produced would be variable at the point of departure where the plate is vibrated by the voice, and constant at the point of arrival, where it is vibrated by electricity. But it is demonstrable that this would not alter the sounds."—*Journal of Telegraph*, *x*, 295.

Rock Crystal seems to be growing more and more in favor amongst technical men on account of the stability of its physical properties. At the August meeting of the Bonn Society of Naturalists it was reported that the directors of the Imperial Mint of Germany have recently ordered of Herr Stern, at Oberstein, several absolutely correct normal weights made of rock crystal, which are to be used for the control of gold coins. These weights have the great advantage that it is unnecessary to determine the specific gravity of every weight, and in the case of measures to find the thermal co-efficient of expansion of every measure, as both are as near constant as possible. They have been found the same in all the specimens of rock crystal yet examined, viz., specific gravity at 0° C. = 2,6506 (reduced to water at 4° C.); coefficient of expansion for 1° C., parallel to the axis, 0·00000750 inch, *i. e.*, seventy-five ten-millionths of an inch.—*Nature*, *xvi*, 447.

Influence of Light on Electrical Conductivity of Substances.—The experiments made by Dr. Bornstein show that the electrical conductivity of the metalloids, selenium and tellurium, increases if exposed to the action of luminous rays, which has the same effect in the case of platinum, gold and silver, and it is thought probable that sensitiveness to light is a general property of all metals. Two methods of measuring the resistance were used to avoid mistake. He summarises as follows:—1st. The property of experiencing a diminished electrical resistance under the influence of luminous rays is not confined to the metalloids, selenium and tellurium, but belongs also to platinum, gold, and silver, and in all probability to metals in general. 2nd. The electrical current diminishes both the conductivity and the sensitiveness to light of its conductor, but both of these, after cessation of the current, gradually acquire their former values.—*English Mechanic*, *xxvi*, 62.

Destruction of Phylloxera.—A French and Swiss commission has made experiments with anhydrous sulphurous oxide under the supervision of Prof. Raoul Pictet, of Geneva, and we are informed found extraordinary results. Those who have seen boiling water instantly frozen or fire extinguished in a second by this remarkable agent will not be surprised to learn that it has been found to annihilate the enemy of the grape.

Mending Alabaster Ornaments.—The *English Mechanic* commends the following as an excellent cement for this purpose: Get a dram of quick-lime, slake it with a little water, powder it very fine and sift it through a very fine lawn sieve. Mix this powder, while quite freshly prepared, with two tablespoonfuls of raw white of egg; work up very smooth with a spatula and apply to the surfaces to be joined, which must be held together with tape straps, etc., until the cement has set thoroughly.

Fifty Samples of Wall-paper recently examined were found to contain arsenic either as arsenic or aceto arsenite of copper. Some papers with green figures were found to be free from arsenic, while, as a rule, the higher-priced qualities contained the poison in the largest quantities. A room of the moderate dimensions of 16ft. square and 9ft. high would be covered, if these papers were used, with "ornamental" surfaces containing from 52 grains to more than 8oz. of poisonous matter.—*English Mechanic*, *xxvi*, 34.

A New Use for Old Corks.—A patent recently issued in France gives the following process for manufacturing cork pasteboard: "Ground cork is thoroughly incorporated in paper pulp by means of mixing-machines and very powerful presses. The board so formed has all the water pressed out and is dried like common paper. Old bottle corks, sole-clippings, and cork in other forms can thus be utilized. The pasteboard is springy, light, a poor conductor of heat and sound, as well as possessing other properties given it by the cork."—*Boston Journal of Chemistry*, *xii*, 41.

Protective Paint for Ship Bottoms.—Herr. F. Heyl of Charlottenburg, has recently received letters patent from England for the following mixture purposed for a protective paint for ship bottoms; 20 parts palm oil, 100 parts Berlin blue and chrome yellow, 20 parts varnish, 10 of shellac, 120 of turpentine, 50 of Euphorbien (?) 15 of chloride of mercury, and 15 parts of arsenic.—*Montan. Ztg.*, xi, 36.

ENGINEERING—CIVIL AND MECHANICAL, &c.

Self-Propelling Street Cars.—The *Pittsburgh Chronicle* says that a very novel piece of machinery is now being constructed at Solo, which is the embodiment of some new ideas in the problem of self-propulsion for street cars, and then adds: The car, now approaching completion at the above place, is designed to travel over Second avenue, between Glenwood and the Birmingham Bridge. The car itself is about the size of an ordinary car, 7 feet wide by 20 feet long, including platforms. There is nothing notable in this part of the affair, but the propelling machinery certainly has the merit of novelty. It is a compound engine driven by compressed air, and communicating its power directly by gearing to the forward wheels of the car, the latter being pivoted so that, by means of a steering device, the whole affair is guided or turned about. The design is to run directly upon the Nicholson or asphalt pavement, after the manner of the Aveling & Porter road engine. The compressed air is not taken from reservoirs at either end of the route traversed by the car, as in the case of the New Orleans self-propelling cars, but is stored up by the engine itself while running. This is accomplished by a hot-air engine acting alongside the driving engine, and pumping the air to a pressure of about 130 pounds per square inch. This engine comes from the Exeter Machine Works, Exeter, New Hampshire, and is eight horse-power. It is very compact, and will be placed beneath the floor of the car out of sight, not taking up more room than a couple of trunks. This engine, after some alterations have been made, will be placed in the car, and in a week, or thereabouts, this novel car is expected to make trips between the points named.—*R. World*, iii, 922.

Stone Sawing with Shot.—There would seem to be no question as to the superiority of iron shot as a substitute for stone sawing. It is found, in fact, that marble may be cut from three to four times as fast by this means, with the same saws, taking about one-half the power in proportion to the quantity sawed, all the power consumed in uselessly crushing the sand being saved. A blade a quarter of an inch thick is found to be worn away an inch in cutting 48 inches deep in granite, or 250 inches deep in marble. The mud from washing is run into catch pits, and the fine particles of iron thus saved are used for smoothing granite, cutting faster and lasting longer than emery. Hard, sharp sand, in being ground to finest mud, will, it is found, wear away about its own weight of glass; course-grained emery, about twice its weight; iron shot, passed through a No. 70 sieve, will wear away fifty times its weight of glass. It is necessary, however, that all journals and rubbing surfaces of the machinery be carefully protected from the shot, as they cut and tear far worse than sand.—*Jeweler*, iv, 9.

A Simple Test for the Presence of Free Acid in Machine Oils, so the *Montan Zeitung* for September informs us, consists in pouring the oil to be tested over a layer of cuprous oxide contained in a glass. (The ash of the coppersmith answers the purpose, since it contains this oxide). If the oil contains either free, fatty, or resinous acid, the same will attack the oxide and color the oil green in a very short time. Slightly heated accelerates the action, which manifests itself in less than half an hour. This test is said to be very delicate and more satisfactory than any hasty test heretofore devised.

Brooklyn Elevated Railroad.—A map has been filed in the Register's office of Kings county, N. Y., of the "Brooklyn Central Elevated Railroad Company." It is to start at Fulton Ferry; run, with a slight ascent, along the upper side of Furman street past Wall street Ferry, at the same elevation as the bridge, to South Ferry at Atlantic avenue; thence along Columbia street to West Baltic, along West Baltic; across Court to Baltic as far as Third avenue; along Third avenue to Douglass street; across Fifth avenue to St. John's place; thence to Eighth avenue, and along the centre of that avenue to the depot of the Prospect Park and Coney Island Railroad Co., at Ninth avenue and Twentieth street, passing through the centre of the block between Nineteenth and Twentieth streets, and reaching the depot on a level with Ninth avenue. It is also in contemplation to have a branch at Fourth avenue to Fort Hamilton. The road will be built after the pattern of the Greenwich Street Road, in New York.—*Chicago Railway Review*, xv, 103.

MINING, METALLURGY AND MINERALOGY.

The Opal Mines of Dubrick, Hungary.—These mines are situated on the eastern slopes of the Labanka Mountains, not far from Dubrick, the workings and waste heaps therefrom stretching for a distance of nearly one-half of a German mile, (1½ miles English.)

The interstices of the Andesite, (a trachytic lava that forms the matrix of the precious mineral), are filled up with opal and hyalite. The felhspathic ingredient of the rock is mostly in a metamorphosed condition, being changed partly into kaolin and partly into opal. The workings are quite extensive, the total length of the several galleries being about two-thirds of a mile, (about two English miles.) The opal-bearing rock is not disposed in vein or bed form; on the contrary, the precious stone is found in nests or pockets, and it not unfrequently happens that a considerable distance may be passed in the workings without showing a sign of an opal. It will, therefore, be obvious that the annual product of these mines will depend largely upon accident or good fortune.

Although the iridescent variety possesses only a commercial value, it is of interest, from a mineralogical standpoint, to note the fact that all the varieties, milk opal, wax opal, fire opal and hyalite occur here in abundance. The last named mineral is often found in most graceful stalactitic forms.

The origin of the opal by the infiltration of water containing silica in solution is here demonstrated in the most convincing manner. Large, precious opals, it is said, are now rarely found, no specimens of the size of a hazelnut have been found for a number of years. The opals described by Pliny are said to have come from this locality. An ancient manuscript of the year 1400 is preserved at Kaschau, in which mention is made that in the mountains of Cservenicza, 300 miners were at the work of opal finding. In former centuries it was universally believed that the Orient was the home of the noble opal, an error which arose from the fact that the gems were sent from Hungary to Constantinople, and found their way from there by way of Holland, back again to the Occident. Formerly, also, the mines were worked by private individuals, but since the year 1788, the proprietorship has been assumed by the government, and the workings are conducted under government supervision, affording at present a yearly revenue of about 15,000 florins, ($6,000.)—*Correspondence of Jahresb., fur Mineralologie*, 1867, 644.

The Petroleum Industry in Russia.—The Russian capitalists who are working the petroleum wells are now lying down iron pipes from the wells to the Black Sea coast, where ships will be loaded by pneumatic pumps. It was recently reported that an American company had petitioned the Government for a concession to work all the petroleum wells in Asiatic Russia. It was pointed out to the authorities, however, that the Americans are aware that Russian petroleum will enter into serious competition with American, and that this was an effort to paralyze the trade.—*The Engineering and Mining Journal, xxiv*, 244.

Pipe Mileage in the Pennsylvania Oil Region.—The total mileage of iron pipe used for conveying oil in the oil regions of Pennsylvania is 2,081¾. The pipe used is what is known as lap-welded or butt-welded tubes, averaging from two to six inches in diameter, with wrought iron screw couplings. This pipe is laid on the surface of the ground, along roads or across the country in the most indiscriminate manner. To allow for expansion and contraction, the pipe is laid not in a straight line between two points, but in curves, curves not being so great but that the force of contraction will draw the pipe without breaking it.—*The Engineering and Mining Journal, xxiv*, 244.

Cinder in Puddled Iron.—To show the amount of finely divided cinder in the composition of puddled iron, M. Chatelier heated a piece of this metal under the action of a stream of chlorine gas, so as to vaporize it. There remained a residuum of whitish green color and very light weight, having the general form of the piece of iron experimented upon. This was found to be composed wholly of finely divided cinder.—*Metall Review.*

Cerro de Pazco Silver Mines.—In a letter to the London *Mining Journal* of the 8th September, we find the following: "The *Mining Journal* of last week contains some statements, reprinted from the Panama *Star and Herald*, concerning these mines, which cannot, in my opinion, be borne out by facts In the first place, it likens this silver-bearing deposit to the 'Comstock lode on a grander scrale.' This is an error, inasmuch as the mines of Cerro de Pasco are not in a lode at all, but are situated in a flat mass of mineral rock, composed of gossan, iron, quartz and pyrites. The deposit, which is exposed at the surface, lies in a hollow or basin, and is from a half to three-quarters of a mile in diameter, surrounded chiefly by mountains of limestone and sandstone, and has no traceable inlet or outlet across these mountains. In some instances, however, where the mass abuts against the base and slopes of the hills, there are observable several small veins containing some lead ore, but they bear no likeness whatever in composition to the silver-bearing ground herein referred to. Furthermore, these veins perish at short distances in the limestone, and have no visible existence beyond. As further proof of it being only a horizontal accumulation or deposit of lode stuff, I beg to inform you that I was engaged by the late contractors, Messrs. Wyman and Harrison, to superintend the underground drainage of these mines, together with sinking two of the shafts 45 yards below the adit, which would give a depth of 150 yards from surface. I proceeded to Peru with a company of men for that purpose in December, 1869, and remained at Cerro de Pasco engaged in the work for nearly two years. While the work was progressing, I expressed an opinion to the effect that in sinking the shafts they would in all probability pass through this mineral formation. The statement was contained in an article on these mines, etc., written on the spot on February 24, 1871, and which you did me the favor to publish in the supplement to the *Mining Journal* on May 6 following. This opinion was subsequently verified at the Gauricocha shaft. This shaft being in extremely soft and difficult ground for sinking, the contractors sub-let it to myself, and when it had reached a depth of 38 varas (yards) below adit, it came upon a hard, spotted kind of rock resembling gray porphyry. Immediately under this was a bed of silt, with loose fragments of water-worn limestone. It appeared to us as if the shaft had now reached the surface of a past epoch, and there was nothing in the material which bore the slightest semblance to the huge mass of mineralized rock reposing on it."

New Minerals.—In a most interesting communication "On Some Tellurium and Vanadium Minerals," made to the Am. Philos. Soc. by Dr. F. A. Genth, he announces the discovery of the following new species:

Magnolite—a product of the oxidation of Coloradoite, (telluride of mercury.) It occurs very rarely with native mercury in the upper decomposed portion of the Keystone Mine, Boulder county, Colorado, associated with quartz, limestone and psilomelane. It crystalizes in fine needles, color white, lustre silky. Ready soluble in very dilute nitric acid and in hydrochloric acid. Composition, mercurous tellurate. ($Hg_2\ TeO_4$)

Ferrotellurite—Occurs at Keystone mine, (as above), associated with native tellurium, tellurite and a peculiar iron sulphide, in which a part of the iron is replaced by tellurium. Composition, (probably), ferrous tellurate ($Fe\ TeO_4$.) It forms a crystalline coating on quartz, resembling delicate radiating tufts, or when in cavities, very minute prismatic crystals, between straw and cream yellow, or inclining to greenish. Insoluble in ammonia, soluble in hydrochloric acid.

Brazilian Coal Mines.—We have on several occasions called attention to the yet undeveloped mining resources of the Empire, which will now be rendered more easy by the accession of railways in their midst. One branch of mining—that of coal—has been completely neglected, owing to the want of native enterprise and the absence of foreign capital, but this, we understand, is likely to be soon remedied by the application of railways connecting the coal mines with the seaboard. Authorities have stated that the carboniferous formation of Brazil is quite equal in extent to that of the United States. Without going to that extent, it is well known that valuable coal deposits exist both in the province of St. Catherine and that of Parana, coeval with deposits of iron, the two forming an element of much future wealth. Heretofore Brazil has drawn her entire supply of coal from England, and during the coal famine some years back she had to pay very dearly for her supplies, but latterly the price has been more moderate.

Looking forward to the development of railways and steam navigation on Brazilian rivers, the question of a local supply of coal becomes of still greater moment, and we hope to see a practical elucidation of it, based on reliable engineering data such as we have before alluded to. It is no use making reports on paper, unless these are followed up by practical results, nor ought there to be much difficulty in this respect, once the public mind is thoroughly imbued with its necessity. Brazil has already spent large sums in reports and surveys of one kind or other, without following the matter up in a more substantial form. Government must take the initiative, as the existing capital of the country is chiefly locked up in the cultivation of sugar and coffee estates, besides other industries.—*Brazil and River Platte Mail.*

The Borax Deposits of the United States.—The principal borax deposits in the United States form a kind of band in the ancient volcanic soil which surrounds the Sierra Nevada Mountains, and some slight reference to these deposits may not improperly be made since borax is a valuable element in glass-making and the ceramic arts, from the fact that it possesses the property, at a high temperature, of dissolving the metallic oxides and forming transparent glass, the color of which depends upon the metal used. It is also largely employed in the manufacture of enamels, glazings for earthenware and strass. In the large glass and porcelain factories of Europe its utilization has only been limited by the high cost of the product, chiefly obtained in Italy; but the discovery of the immense borax deposits in this country has materially removed this restriction, so that at the present time its employment is rapidly extending, and the export of the salts bids fair to become a very important branch of our commerce.

Some interesting information relative to the mode of working the borax deposits of California and Nevada is given in a report recently made by Mr. Emil Durand, who has had several years experience in the extraction of the material, to the French Society for the Encouragement of National Industry. A thin steel shovel with a sharp edge for cutting the herbage is used for collecting the salt, which is taken in carts to a platform placed above large wooden vats capable of containing some 3,500 gallons. These vessels are filled with water, heated to boiling by the injection of steam. The borax is thrown in by shovelsful until the areometer marks 23° B. This concentration would be too great if only borax were put in, but the impurities (sulphate of soda and rock salt) added, besides the mud and borate of lime in suspension, greatly augment the density. When the above degree is reached the solution is allowed to rest, the herbage which floats on the surface is skimmed off, and the liquid is carried off by long India-rubber tubes into the crystalizing vessels. The latter are large tanks 9 feet 6 inches in length, about 6 feet high and 39 inches wide. The liquid cools slowly to a temperature of 78°, occupying about ten days in so doing. A faucet at the lower end of the tank is then opened, and the mother liquor, mud and large borax crystals which are formed by aggregations of small crystals are removed. The crystals are washed with the mother liquor in another vessel, by agitating them with a rake in a long trough filled with water. They are afterward kept for refining. At the bottom of the crystalizing vat is found a deposit of borax, sometimes six inches in thickness, which is broken up with the pickaxe. The salt is then left to dry on the platforms for four or five days, and finally is packed in coffee sacks, the bag filled weighing 165 pounds.

The cost per pound is San Francisco is about is about 8½ cents. The monthly production of borax in California and Nevada is estimated at 200 tons.

Diorrexine.—It appears that in Germany this explosive is becoming popular among coal miners. It was invented by Mr. G. Pancera, and large quantities are now manufactured at Sistiana, in Triest, and at Brunn, near Wiener-Neustadt. In the dry explosive there were found by the analysis by Mr. J. Fels, of Triest: Picric acid, 1.65; charcoal, 7,49; beech sawdust, 10.97; potassic nitrate, 42.78; sodic nitrate, 23.16; sulphur, 13.40; loss, 0.55; total, 100. Diorrexine is about 25 per cent. lighter than Austrian blasting powder, and of about equal strength, whilst it does not cost more than one-fifth.—*Engineering and Mining Journal, xxiv*, 263.

—Coal oil has been discovered near North Middleton, Bourbon county, Ky. The supply is thought to be abundant, and arrangements for machinery to work the wells are being made.

—Extensive coal mines have been digcovered in Stephens county, Texas. They are said to underlie pretty much the whole county, and the coal is of excellent quality.

MISCELLANEOUS.

Pedestrian Training.—Last month a pedestrian named Smyth, and appearing under the name of "The American Postman," achieved the task of walking three hundred miles in six days, at Dublin. His regimen during the walk was as follows: He takes a small chop and some cocoa for breakfast. In two hours afterward a raw egg beaten up. His dinner consists of a sago pudding and a small quantity of very raw beef, without drink, and his supper of as much cocoa and bread and butter as he wishes. Each day he is allowed a quart of milk and occasional sips of ginger ale. He takes no alcoholic beverage whatever.—*Medical and Surgical Reporter, xxxvii*, 237.

To supply a sudden demand for links and pins arising from the destruction during the strikes, Messrs. Wilson, Walker & Co., of Pittsburgh, received an order of 40 tons of links and 20 of pins, and the whole order was made and shipped in six days. Their link machine takes the hot iron from the rolls, cuts and bends it, and prepares it for welding at the rate of 15 tons per day.

Lovegrove & Co., Philadelphia, have six orders on hand for engines and boilers to be shipped to various cities in Germany. They have also received inquiries from Sweden.

Alfa, the Algerian Esparto Grass.—The *Papier Zeitung* contains an interesting letter from Algiers on the subject of alfa. The correspondent states that it is unjust that alfa has not brought the same price as esparto. The plant *Stipa tenacissima* is common to both Algeria and Spain; the Arabs calling it *alfa*, the Spaniards *esparto*. The English, in order to keep a monopoly of the alfa trade in their hands, have industriously sought to lower the article in public estimation, and only on this account can the superior favor which esparto enjoys in Germany be satisfactorily explained. The esparto trade is almost entirely in the hands of the English; even German paper-makers drawing their supplies from them. There is one great advantage possessed by alfa—its practical inexhaustibility. The Alfa Sea, as the region where it mostly grows is called, is 400 kilometres long, with a minimum breadth of 100 kilometres, or a surface of 10,000,000 English acres. No other vegetation exists in this immense region, neither tree nor plant. The alfa requires no culture, but will much improve by it. The first crop is always inferior to succeeding ones. Morocco, Tunis, and Tripoli can furnish immense quantities.

With such a supply there can be no fluctuations in price, for there are no bad harvests to fear. Good dried and sorted alfa can be had at the place of production for £2 per ton; the average distance from port is 170 kilometres. The prices ruling in England are about £7 per ton. As these prices are owing to the cost of transport of the raw material, it is suggested that factories for the preparation of alfa should be established in Algeria, but against this there are the natural disadvantages of having to import other materials there, and the difficulty of having competent workmen. There is little doubt, however, that the Germans will try and establish a direct trade in the article.—*Paper Trade Journal*, *vi*, 297.

The Manufacture of Mosaics.—The modern process of making mosaics now commonly followed at Rome is this: A plate, generally of metal, of the required size is first surrounded by a margin rising about three-quarters of an inch from the surface. A mastic cement, composed of powdered stone, lime and linseed oil, is then spread over as a coating, perhaps a quarter of an inch in thickness. When set, this is again covered with plaster of Paris rising to a level with the margin, upon which is traced a very careful outline of the picture to be copied, and just so much as will admit of the insertion of the small pieces of smalto or glass is removed from time to time with a fine chisel. The workman then selects from the trays, in which are kept thousands of varieties of color, a piece of the tint which he wants, and carefully brings it to the necessary shape. The piece is then moistened with a little cement and bedded in its proper situation, the process being repeated until the picture is finished, when the whole, being ground down to an even face and polished, becomes an imperishable work of art. The process is the same for making the small mosaics so much employed at the present day for boxes, covers or articles of jewelry, and this work is sometimes upon almost a microscopic scale.

The Florentine mosaic, which is chiefly used for the decoration or altars and tombs, or for cabinets, tops of tables, coffers and the like, is composed of precious materials in small slices or veneers, and by taking advantage of the natural tints and shades which characterize the marble, the agate or the jasper, very admirable effects may be produced in imitation of fruit, flowers or ornaments. The use of this kind of mosaic is extremely restricted, on account of the great value and expense not only of the materials, but of the labor which is spent upon them. None but the hardest stones are used; every separate piece must be backed by thicker slices of slate or marble to obtain additional strength, and every minute portion must be ground until it exactly corresponds with the pattern previously cut.—*Jeweler*, *iv*, 11.

—The channel span of the bridge over the Ohio river at Cincinnati, built by the Keystone Bridge Company, of Pittsburgh, for the Cincinnati and Southern Railway Company, has just swung clear of the false works. This is the largest span—520 feet—of truss bridge in the world. The upper chord is 185 feet above ordinary water, and weighs about 1,300 tons.—*R. World*, iii, 894.

—It is authoritatively announced that the first of the line of steamships to take her place in the regular line to ply between New Orleans and South American ports, is now *en route* from Liverpool to the former city. The proposed line, of which this steamer is the pioneer, will comprise several first-class vessels of large tonnage, with a carrrying capacity fully equal to the wants of the trade between the two sections. Should this trade expand to large dimensions additional steamers, with a large capacity, will be placed in the line.—*R. World*, iii, 895.

The 16-pot plate glass Siemens furnace, lately built by the Crystal Plate Glass Co., of St. Louis, has been started up and is working very satisfactorily. It is reported to be saving 60 per cent. of fuel and giving a greatly increased yield of glass, with a decided improvement in the quality. We believe also that there is a great saving in pots, owing to the facts that with the Siemens furnace the breakage is slight.—*Iron Age.*

Japanese Industries.—If the news from Yokohama is correct, our Japanese trade is seriously threatened by the ingenuity of Japanese workmen. A letter has been received by a large manufacturing house in Birmingham from its agent at Yokohama, in which he says: "The Japanese are now making a number of articles which I formerly purchased from you at prices beyond the possibility of European competition. In fact quite a number of different classes of merchandise are being made in this country, and Europeans are obliged to discontinue importing in consequence Since I last wrote you I have been offered a large order for your goods, but at a price at which I should lose about 10 per cent.; yet a factory at Osaka has taken the order and is now making the goods." These Asiatics, the writer says, undersell every labor market which they enter and outdo every civilized artisan at his own trade. The Japanese, he remarks, are always ready to learn, and to outvie everything that the West does, and this they do with less food, less air, and less clothing than any civilized workman. It is the conviction of the agent of this Birmingham firm that the Japanese "will become formidable rivals of all kinds of Western manufacturers." It may be added that in Japan the import duties are only 5 per cent. *ad valorem* on the class of merchandise to which this letter refers.—*The Engineer*, xliv, 187.

Mr. A. T. Cataldi writes to the *Leeds Mercury*:—"The Caxton celebration being an event which by its very nature can only recur at a stated future time, all that refers to it should be at once presented. Is it presumptuous in me to wish to add my mite, which I do not see mentioned in any of the interesting information afforded hitherto? John Guttenburg, or Gutenburg, one of those to whom the art of printing is attributed, had for partner, as is well known, one John Faust, or Fust, who had passed some time in Italy, namely in Venice, with a certain Panfilo Castaldi, of Feltre. This last is the person to whom I would call attention, as a link in the chain concerning the yet doubtful awarding of the palm for the invention of printing. Castaldi having seen several Chinese books which Marco Polo, of traveled celebrity, had brought from China, printed by means of wooden blocks, constructed movable types, each containing a single letter, and with these printed a number of sheets, some of which are preserved to this day among the archives of Feltre. With Castaldi John Faust spent some time, and acquired from him his invention, which, after his return to Germany, Gutenburg developed with him into the art of printing. As the inventor of this art, Castaldi's fellow-citizens erected a statue to his memory in his native town of Feltre, which lies on a height near the Piavo. Is it not somewhat of a duty to recall Panfilo Castaldi (at different times or periods variously written Castuldi and Castildi) at this time, to compare with others, even after so many centuries, of his meed of the appreciation which is being expressed through the present celebration in memory of one of the greatest workmen in the art of printing? To the duty of this sentiment permit me, as a descendant, to call attention."

—Three miles of cars are standing on the tracks at Altoona, all filled with "scrap" from the ruins of round-houses, rolling stock, etc., destroyed by fire in Pittsburgh by the rioters.

John C. Graham, of Grandville, Mich., contributes to the *Scientific American* the following rule for estimating shingles for roofs: Divide 3,600 by the number of inches to be laid to the weather, and multiply this quotient by the number of squares to be shingled, and the product will be the number required.

The Woolen Industry of the United States.—We regret the woolen industry does not exhibit much real recuperation from the depression which commenced to show itself in the autumn of 1875, and to which we alluded so fully in our report. Since published, more machinery has ceased running, continuing the process of "a survival of the fittest," through which alone we can get back to a sound condition of things. Some profits were made last summer on a low basis for the raw material, and with an exceptional demand for goods from Exhibition visitors. But an advance in the former and the withdrawal of the latter, combined with an unusually severe winter, have since seriously checked all business and reduced prices, so that spring fabrics are being sold at a loss to the producer. When we inform our foreign readers that the best makers of fine goods in this country have sold their light weight fancy cassimeres, *nouveautes*, 8 ozs., at $1 per yard, say 4s. stg.; and summer cheviots of choice workmanship at 2s. 6d.—lower than the average before the war—some estimate may be made of the badness of the trade We do not think the political uncertainty has much to do with it. It certainly gave a chill to the feverish patient, which he would have quickly thrown off had he been stronger. The trouble goes deeper, and will not be surmounted until we find a way of employing the thousands of idle hands, more unable than ever, apparently, to earn anything beyond the bare necessities of life. There is evidently too much machinery for our domestic wants, and disaster must overtake the surplus sooner or later. This bankrupt surplus, compounding with its creditors at a nominal figure, again becomes a producer on a basis of cost much lower than its struggling rivals. In time it will inevitably undersell the latter, which may eventually be compelled also to succumb to this greater strain. The trouble seems endless, unless the surplus machinery can be absolutely destroyed, or until we find a foreign outlet. The cotton spinners have groped through their difficulties to this result, and are now comparatively prosperous. When the iron and woolen and other artificers find employment in the same direction, and when our currency is on a gold basis, we may be sure general prosperity is not far removed. To this end prompt legislation is greatly necessary to supplement the progress we have already made in the manufacture of woolens. This is forcibly shown by the following figures, giving the yearly importation of woolens of all classes from England, whence the bulk comes to this country:

1873	$27,610,900
1874	21,188 890
1875	16,976,700
1876 (estimate)	12,000,000

These figures furnish us an appropriate comment upon the following remarks made by M. Leydoux, a French authority of standing, upon his return from the Centennial Exhibition:

"With their vigorous march and rapid progress we perceive one of these days that Americans will be the redoubtable adversaries of England first, and soon after France, and that America will seek among us, in the name of free trade, consumers for its manufactured articles. Shall this be in ten or twenty years? Without venturing further into the depths of the future, we clearly see American products holding in check those of Europe."—*Annual Report of N. Y. Chamber of Commerce.*

The Jacquard and Lace Loom.—Draper, in 1834, 1835, and 1837, took out patents for Jacquard application to the the lace frame. He was the earliest and most ingenious, though not most successful, pioneer in finding out how every thread in a machine might be as simply and perfectly controlled as those on a pillow by the fingers of a workman. Money failed Draper before he had quite accomplished this; but his diversified combinations of lace machinery were the real germs of those which have been perfected by his successors, with great profit to themselves and to the establishment of the trade—yet this clever mechanic fell into deep and unassisted poverty.

By 1840, the application of the Jacquard to the lace machine had been effected. Oldknow, in 1849, added the use of very thin steel bars, pierced so as to pass warp threads through them, and guiding the movement of each sideways right and left. Articles are thus made from the narrowest braid to a highly-figured lace-curtain two yards wide, and requiring ten or twelve thousand cords to produce the pattern. Oldknow granted 1,170 licenses, and now 3,000 machines are using his perforated steel-bar invention. The complex operations governed from the ends and backs of Levers' machines, are carried on in a small space, but through their whole width of perhaps two hundred inches, safely and exactly, prompt attention being given to remedy any defects in materials or workmanship.

In 1841, Deverill had patented a claim to the first successful application of the Jaquard to the end of a lace frame. Birkin bought the invention from Deverill; but seeing a doubt arise, relinquished his supposed right, and, with most praiseworthy spirit, thus restored freedom of action to the fancy lace department, in which direction alone general profit was to be hoped for.

This excellent mechanician had been engaged in early life at the Belper cotton mills, improving his leisure time in reading and mechanical efforts. Removing to Nottingham in 1822, he learnt, while at work in one class of lace machinery, the principles on which all were constructed, Each was realizing to the owners of a machine making fancy laces £20 to £30 weekly, and £5 to £10 a week to diligent workmen. Birkin husbanded both time and money, and taking the tide at the flood, it led him on rapidly to fortune.—*British Manufacturing Industries*, 1876.

The Satellites of Mars—Since our article on this subject was in type, we have received the following note from Dr. Robert Reyburn, of Washington, D. C.; "In the recent accounts of the discovery of the satellites of Mars, we have not seen any reference to the curious fact of the announcement of their existence by Dean Swift in his celebrated satire of 'A Voyage to Laputa,' published in 1726. It may be found in the third chapter of this work, and reads as follows: 'They have likewise discovered two lesser stars or satellites which revolve about Mars, whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost five; the former revolves in the space of ten hours, and the latter in twenty-one and a half, so that the squares of their periodical times are very near in the same proportion with the cubes of their distance from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences the other heavenly bodies."

This was expressly written to cast ridicule upon the astronomers of his day, and now about one hundred and fifty years afterwards it become numbered among the established facts of science."—*Boston Journal of Chemistry*, *xii*, 45.

Dynamite Cartridge placed on the forehead and exploded by means of electricity, have lately been employed in England for killing cattle.

The International Leathre Exhibition took place at Berlin, on the 8th of September. It is reported as having been very successful and interesting.—*D. All. Poly. Ztg.*, v, 432.

The Water We Used During Last Year.—From the annual report of Dr. McFadden, Chief Engineer of our Water Department, which has just been published, it appears that during last year there were pumped 17,473,308,039 gallons of water, an excess of 2,376,146,970 gallons over the quanity pumped in any previous year. The daily average was 47,741,279 gallons; the maximum nearly 72,000,000, and the minimum 27,000,000.—*The Times.*

Philadelphia Foreign Trade.—The *Ledger* says: "The recent efforts made to increase our exportation of home manufactures to foreign ports have resulted so successfully that during July and August, $518,985 worth of these manufactures were exported from Philadelphia, embracing a wide range of articles. We sent out passenger cars to Brazil and Cuba, coal to the West Indies and South America, car wheels to Brazil and Antwerp, nine locomotives to Brazil, machinery to Brazil, Liverpool, Antwerp, and elsewhere; nails to Rio, Peru and the West Indies; iron pipes to Cuba, butter and lard; leather to Liverpool and Antwerp, paper to the West Indies, petroleum, soaps, and a large amount of other articles. This trade promises to continue, and in many branches to increase."

The New Steamship Line.—The establishment of a new steamship line between New York and Venezuela has caused considerable discussion in commercial circles on account of the liberal action proclaimed by the government of that republic. The new steamers of this new line to Venezuela are chartered to run until a question of the amount of trade is decided. Arrangements have been made to build two iron steamers of one thousand five hundred tons each, and of large carrying capacity, to be put on the route during the next eight months. Rates of freights and passengers of the new line have been fixed at seventy cents per barrel, twenty cents per foot measurement and one hundred dollars cabin passage.—*American Manufacturer, xv*, 4.

Report of Short-sightedness of Scholars in German Schools have frequently been noticed, but the following statesments made by Dr. Kotelmann demand further inquiry. Of 413 boys at one school he found a defect of vision of some kind or other in 42 per cent., the principal defect being short sight. In the lowest class that defect was found in only 14 per cent., but in the highest more than half, or 61 per cent. were found to be more or less seriously affected with short sight. Classing the boys according to their ages the defect becomes still more serious, for of those below the age of 10 only 16 per cent. were short-sighted, while amongst the oldest pupils (those between 18 and 20) the proportion rose to 75 per cent., or, in other words, out of four German youths educated at the principal school in Hamburg, three of them would be short-sighted on reaching manhood. It is possible that in some, perhaps many, cases the evil is hereditary, but there are other causes at work, not the least of which are the arrangements employed for lighting the rooms, and the barbarous type in which German school-books are printed.—*Eng. Mechanic and World of Science, xxiv*, 62.

Glass Veneers.—A company was recently formed in New York for the porpose of manufacturing, as they term it, "glass veneers and decorations on glass," consisting of plate glass painted on the back, which is glued to the wood or other material it covers or adorns. Specimens of their work are excellent imitations of the various woods represented—such as birch, ash, French walnut, gray maple, rosewood, mahogany, bird's-eye maple, satin wood, etc. For panellings, wall and ceiling decorations, marquetry, imitations of the different marbles, tiles, etc., we know of nothing to equal this new manufacture, and predict for it a great success, combining as it does cheapness and beauty. Mr. Budd, the inventor, has had a piano-forte in use for the past two years, covered with glass veneer, during which period it has been removed three times without breakage or even a scratch.—*Manufacturer and Builder, ix*, 223.

—D. S. Wittenhall, the inventor of an iron railway tie, manufactured in Chicago, has secured contracts for a number of his ties from the Kansas Pacific, Atchison, Topeka and Santa Fe, Denver and Rio Grande, and Colorado Central Railroads. They will be rolled in Chicago as soon as possible, and these roads will make a thorough trial of their merits during the coming fall and winter.—*R. World.*

—The Smith Bridge Co., of Toledo, Ohio, have contracted for 130 bridges since January 1st, 1877, fifty of which are completed, and the balance to be completed by January 1st, 1878.

—The Edgar Thompson Steel Works have just had placed in their works a drop for testing full sections of rails or axles. The drop weighs 1,640 pounds and has a fall of 47 feet.

—The Oregon Steam Navigatlon Company has entered into a contract with John Roach for a new steamer, to be called the Multnomah. She will be 300 feet long, and have a carying capacity of 3,100 tons on a draft of sixteen feet of water. She will be built of iron, with compound engines like the Elder and the City of Panama.

—Street cars were run in Dundee, Scotland, for the first time on the 29th of August.

—Among the one hundred and twenty-four ships struck off the English register in July, was one built in 1756 and launched in 1788.

—It is proposed to build a bridge across the Maumee river just above Toledo, which will be 2419 feet in length and will cost $55,000.

—The Woonsocket (R. I.) Machine Company report that in addition to their domestic orders, they have received a considerable number from Europe. A few days ago they sent a lot of shafting, hangings and pulleys to Amsterdam, Holland.

—The Lawrence (Kan.) *Journal* says: "The Searcy railroad, in Arkansas, consists of four miles of wooden rails laid on a natural roadbed. The equipment is one car; the working force is one man; the motive power is one mule, and the fare from the outside world to Searcy is $1. There was no strike on the Searcy railroad.—*The National Car-Builder, viii*, 148.

—Red cypress is believed to be the best wood in the world for railroad ties. Some red cypress ties on the Louisiana and Texas road have been down seventeen years and are still sound.—*The National Car-Builder, viii*, 148.

ANSWERS TO CORRESPONDENTS.

THE "BUFFALO." (C. C., Trenton, N. J.) There is not a native buffalo in this country. One so-called buffalo (*Bos bison, Bison Americanus*) is a bison, and about as much like the Eastern buffaloes (*Bufalus*) as it is like a zebra or an ox. Look up some good work on natural history.

PERPETUAL MOULD MATERIAL. (W. P., Trenton, N. J.) We do not know of any material porous enough for iron casting, that has "bind" enough in it to permit of being used over and over again without the mould being broken up when the casting is removed.

FLOCK POWDER. (J. E. T., Phila.) Ground waste wool makes the best flocking for papers, &c.

CORE-PRINTS. (I. C. D., Brooklyn.) Cores do not have to be held up against their own weight, as much as to be *held down* against their tendency to float in the liquid metal. Hence you have found your core-prints too small.

FINENESS AND CLOSENESS OF WOOL FIBERS. (W. B., Newark, N. J.) A merino sheep will carry 600 to 700 fibers in an inch in length, or 36,000 to 48,000 on a square inch of skin.

"SHODDY." (W. A., Dover, Del.) This is not entirely to be condemned, if goods are sold as shoddy and are not *all* shoddy. "Mungo" is rag wove from finer grades of cloth.

DRAW-PLATES PULLING OUT. J. T. F., Wilmington, Del., says that "draw-plates are troublesome by reason of pulling out." Put them on the under or bottom side, bore a hole through to meet each one and run the draw-iron clear through, and they cannot pull out.

FELTING OR FULLING. (H. W. M., Paris, Ky.) *Cotton* will not felt, or full, because its fibres lack the scales or projections which are on wool fibres and which interlock and "close up" the fabric.

COMPOUND HAMMERS. (H. T., Erie, Pa.) A forging struck from top only does not get all the blow properly; is is cushioned. Striking from both sides saves half the heating, and thus saves the metal from injury, while none of the blow is wasted.

WOOLF AND WOLFF. (P. O. C., Balto.) Woolf's patent was in 1804, Wolff's in 1834; and compound engines having two cylinders and intermediate reservoir should be called, not Woolf, as is generally the case, but *Wolff* engines.

CORRECTION. In the algebraic problem answered in our issue or September 1st, the decimal part resulting from the solution of the quadratic, was discarded, and the answer was therefore correspondingly increased. The result should be 54.15 miles and not 60. The solution was hastily made, and was designed to illustrate the method of solution rather than to obtain an answer correct in all particulars. The number of replies correcting the result, that we have received from correspondents, warns us to be particular in future to "get matters down fine."

SELECTED LIST OF U. S. PATENTS.

194,960. MACHINES FOR CLEANING PAPER-PULP SCREENS. Wm. H. Elliot, New York, and Leonidas F. Clark, Ilion, N. Y. [Filed Apr. 10, 1877.]

Brief.—Removes from the prepared pulp knots, &c., that gather upon the screen-plates by means of a brush or rake having a reciprocating motion, operated by a double screw. The brush is provided with trips, whereby it is raised during its movements in one direction, but let down so that it will rest upon the screen-plates while moving in the other direction. The connecting rod is provided with a sliding joint, whereby the movement of the brush may be brought to a rest for an instant at each end of the screen.

194,962. SCREW-CUTTING MACHINES. L. Field, Media, N. Y.

Brief.—The duct leading from the reservoir for the lubricant passes through a collar or band upon the chuck carrying the cutters, which chuck is provided with a channel, over which the collar fits, and with which apertures leading to the cutters communicate.

194,965. ORE-CONCENTRATORS. Thomas M. Healey and Charles W. Rogers, Washington, D. C.

Brief.—Ore is passed into the distributer, which is provided with false bottom and bottom slide, whereby the ore is held in contact with water before passing to the belt. It passes thence to the belt, meets a descending stream of water, which carries off the lighter portions, and the heavy material passes on against the stream. Residue is removed by beater and water-jet below.

194,995. SEWING-MACHINES. William G. Cummins, Cookeville, Tenn.

Brief.—The cam, fixed to the driving-shaft below the table, is connected with the belt-pulley by means of a pin, the connection being maintained except when the bobbin-winder is pressed against the driving-pulley. This throws the driving-shaft out of gear with the stitch-forming mechanism, and by means of the peculiar construction of the bobbin-winder, raises the presser-foot from the work.

194,998 MACHINERY FOR CHARGING GAS-RETORTS. Chas. F. Dieterich, Baltimore, Md.

Brief.—The charging-scoops are adjusted beneath the coal trough of the coal-carriage, and are there filled with coal by inverting the troughs. The scoops are then projected into the retorts, and the coal deposited therein by the withdrawal of their sliding bottoms, the coal being retained by cross-bars in the scoops. A turn-table on the truck of the charging-scoops permits their being turned for adjustment with the coal-trough or with the retorts. The scoops are vertically adjustable in their frame, so that they may be run into the retorts at different elevations.

195,935. SHEET-METAL-PAN MACHINES. T. R. Morgan, Alliance, Ohio, assignor to W. D. Wood & Co., McKeesport, Pa.

Brief.—A stationary blank-support is surrounded by a vertically-sliding frame, operated by a series of toggle-levers, and carrying rollers, which press upward hinged flaps on the support, to fold the edges of the blank upwardly about a holding clamp, which is also operated vertically by toggle-levers.

195,036. MOLDING PULLEYS. Henry Nadig and Philip Nadig, Allentown, Pa.

Brief.—The drag half of the flask is inverted on table; half pattern is inserted; also two registering-tubes over holes in table. Pins are elevated part way through tubes. Tamp, lower the pins, remove and reverse half-flask; insert dowel-pins in the tubes. So treat cope half of flask, and place its registering-tubes over dowel-pins in drag half to register the mold.

195,075. WIRE-BRUSH MACHINES. John Ashworth, Somerville, assignor to Benj. Poland, Arlington, Mass.

Brief.—An inclined conveying and assorting device receives headed pins from a hopper, and delivers them, point downward, to a rotating notched disk-holder, which deposits them singly into an inclined trough, from which they are seated, by a follower, in a perforated backing automatically fed.

195,079. SPINDLES, BOLSTERS AND STEPS FOR SPINNING-MACHINES. John T. Beall, Petersburg, Va., assignor to himself and Wm. H. Wheary, same place.

Brief.—The upper bushing of the bolster is surrounded by a fibrous packing, which reabsorbs the oil that accumulates in the cup above. The two bearings (the upper and lower) by their particular arrangements of parts serve to supply oil from a single point to all parts of the spindle, bolster, and step which are in frictional contact.

185,088. COMBINED STEAM AND GAS GENERATING APPARATUS. Wm. F. Browne, New York, N. Y., assignor to Hydrocarbon Steam Generating Company.

Brief.—Steam and liquid hydrocarbon are decomposed by passing them through incandescent carbonaceous matter in retorts, and the gas thus generated is supplied by tuyere-pipes above and below the retorts in the fire-box, where it is burned. The hydrocarbon liquid and steam previous to admission to the decomposing-retorts are passed through a superheating-coil in the chimney of the furnace. Coal-gas is generated, enriched by liquid hydrocarbon, and purified by passing through purifying substances placed in a chamber below the combustion-chamber. The heating and the illuminating gases are stored, and the later are compressed into receivers for distribution.

195,147. TORPEDOES FOR OIL-WELLS, D. C. McIntre, Elk City, Pa.

Brief.—A detachable tube connected to the bottom of the torpedo contains a sliding rod, which, when the torpedo is lowered, strikes the bottom of the well, and serves as an anvil upon which the cap on the lower part of the torpedo is exploded to ignite the charge.

195,180. CUTTER-HEADS. J. B. Stockham, Jackson, Mich.

Brief.—In a cutter-head having one three-part routing-cutter and one three-part planing-cutter the inner side of each outer bit is recessed, to allow it to spring inwardly under the pressure of a set-screw.

195,181. PIPE-CLEANING TOOLS. Samuel D. Strohm, Philadelphia, Pa.

Brief.—A rod with a handle carries a cap and stuffing-box with bearings, to fit on a tube, the opposite end consisting of a reduced rod with a drill-bit at its end, and spiral wire around to conform to a curve in the pipe, the spiral wire being flattened to pass through the elliptical bore in the plug of a stop-cock.

195,182. EXHAUST FANS OR BLOWERS. B. F. Sturtevant, Boston, Mass. [Filed July 30, 1877.]

Brief.—The mouth-piece being reversible, can be changed to either side of the case. The two bearing-boxes, pivoted and adjustable, are supported by a hollow bracket, which receives the waste oil. The fan-wheel has sheet-metal arms and blades.

495,183. HAND FIRE-ENGINES. Levi Taylor, Marlborough, Mass.

Brief.—The body of the engine, with its operating parts, is detachable from the carriage on which it is mounted. Each piston-rod is so pivoted as to form one arm of a toggle-joint, the other arm being formed by that part of the curved portion of the brake-lever situated between the central pivot and the point where the upper end of the piston-rod is pivoted.

195,186. IMPLEMENTS FOR LAYING TILE. W. L. Tyner, Stanford, Ill.

Brief.—From the lower end of a staff or handle projects at right angles a jaw or finger. At a short distance from this is a stud, which supports one end of a rod, the lower end of which rests in the permanent jaw. A moving jaw slides upon the rod and a groove in the handle, and is held in contact with the permanent jaw by a coiled spring. A rod connects the movable jaw with an angle-lever near the upper end of a handle, by which the spring is contracted, thus separating the jaws.

195,194. MACHINES FOR FORMING THE WARP-EYES OF WIRE HEDDLES. Abijah J. Williams, Utica, N. Y., assignor to J. H. & N. A. Williams, same place.

Brief.—Expands the ends of the eye from the inside outwardly and against the force of the ordinary twisters by a slide operating pivoted jaw, to shape the eye and compact the twist at each end of the eye.

195,199. BRICK-MACHINES. H. C. Sergeant, New York, N. Y.

Brief.—The clay is fed into the mold from the bottom of the hopper, where it is pressed by a plunger, and upon lowering the mold, which is effected by cams and levers, the finished brick is ejected by a second plunger. The recess in the upper part of the sliding mold-plate allows the pressing-plunger to enter the mold slightly beyond the line of contact with the stationary plate forming the front of the hopper.

REISSUES.

7,876. PAPER-BAG MACHINES Christopher Amazeen, New York, N. Y., assignor, by mesne assignments, to the Union Paper Bag Machine Company, Philadelphia, Pa. Patent No. 84,076, dated Nov. 17, 1868.

Brief.—The paper as it passes into the machine has paste applied to one side of its margin, and is fed forward to toothed knives, which sever a bag length. The detached pasted piece is then passed on beneath a plate or former, around which it is shaped into tubular form by bent guide-plates. The paper being delivered from this former has its pasted side pressed upon the adjoining edge. One side of tube is now longer than the other, in view of the shape of the knives, and as the tube travels forward paste is applied, by a reciprocating paste-roll, to said longer side, (the bottom side,) after which a descending folding-blade folds it over upon the top side of the tube, and passes between presser-rolls, and is discharged a completed bag.

7,881. MACHINE OR BATTERY GUNS. Benj. B. Hotchkiss, New York, N. Y. Patent No. 130,501, dated Aug. 13, 1872.

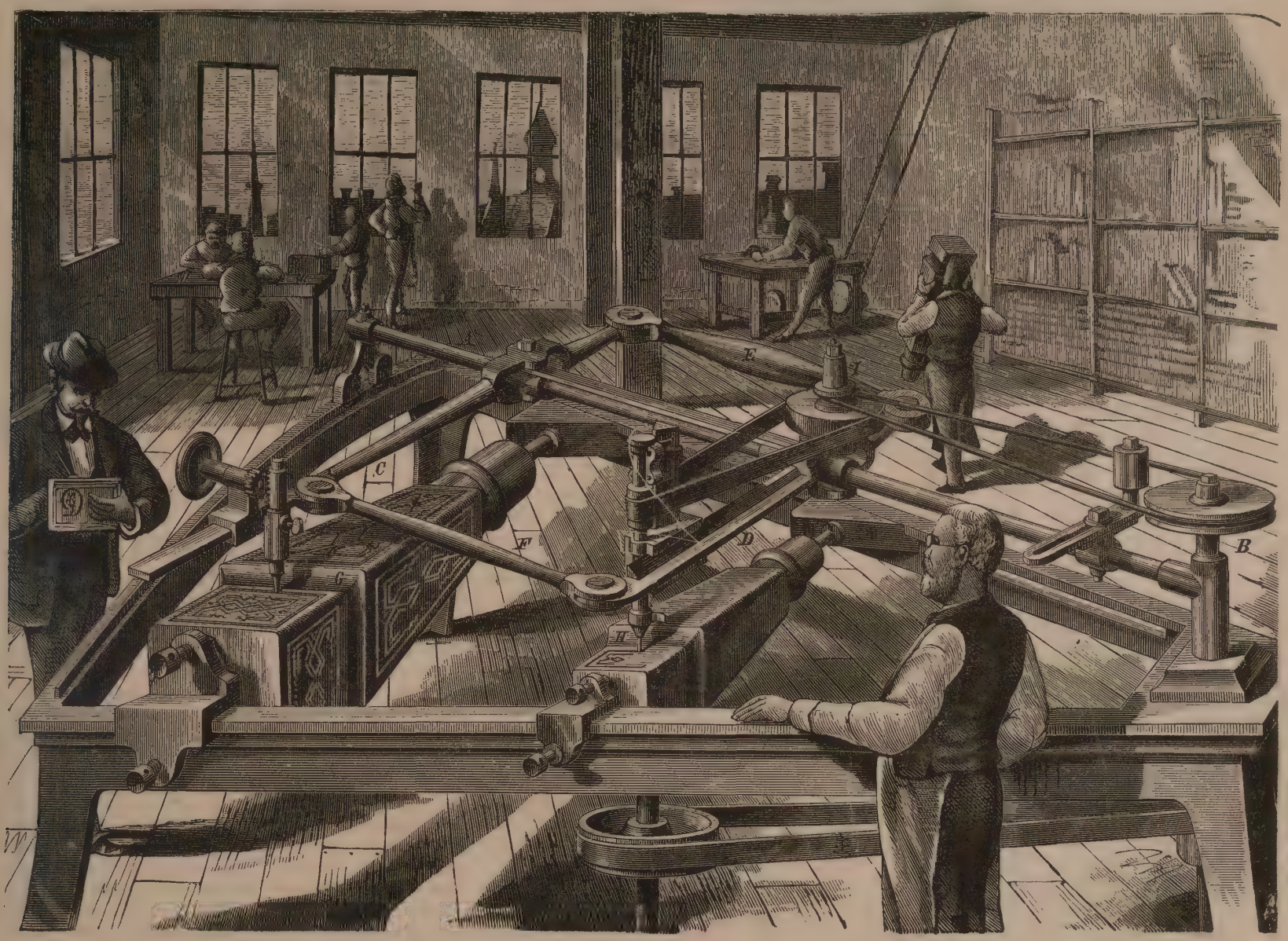
Brief.—The cartridges are placed in an inclined trough, and are fed into the gun by their own gravity. The first half-turn of the actuating-shaft brings one of the barrels into line with the loading bolt or plunger. The second half-turn moves the plunger forward to load the barrel, and at the same time the cartridge in the preceeding barrel is fired and the shell extracted from a third. By a peculiar construction of the worm-gear by which the barrels are rotated they are held stationary during a portion of each revolution of the actuating-shaft, during which interval the operation of loading, firing, and extracting the shell are performed.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

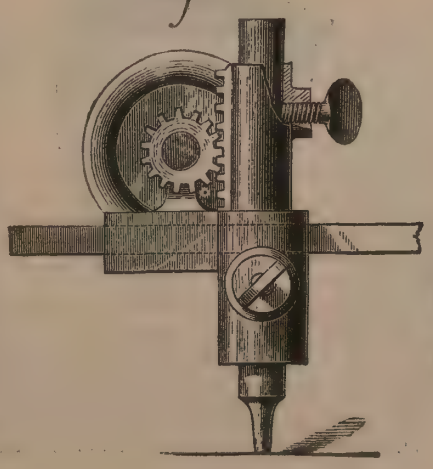
VOL. IV PHILADELPHIA, OCTOBER 20, 1877. No. 16.



IMPROVED WOOD-CARVING MACHINE.*

The machine, herewith illustrated and described, is nearly identical with the pantagraph, an instrument used by draftsmen for duplicating drawings on an enlarged or reduced scale, the carving cutters being substituted for the pencil used in that apparatus. *A* is the principal rod or shaft upon which the working part of the device is supported. Its inner end is attached to a sleeve which surrounds the vertical driving shaft, *B*, which serves as a center for the circle, an arc of which is described by the outer extremity of the rod which is mounted on slides or rollers which traverse a curved track upon the table. Pivoted, as shown, to collars which slide freely upon the rod, *A*, and which may be adjusted thereon and clamped in position by set screws, are bars, *C* and *D*, on the pantagraph frame. Said bars are connected with two other pivoted bars, *E* and *F*, which complete the square. The bar, *C*, carries the pattern tracer, *G*, and the extremity of the said bar serves as a handle for the workman to guide the tracer into the various curves and indentations of the pattern .Mounted adjustably upon bar. *D*, is a vertical shaft which carries the cutting tool, *H*. Said shaft is driven by a belt from the pulley, *I*, fixed at the central portion of the bar, *D*, which, in turn, is actuated by another belt from the pulley located on the summit of the vertical shaft, *B*. Shaft *B* is belted to the driving pulley shown under the table.

Fig. 2.



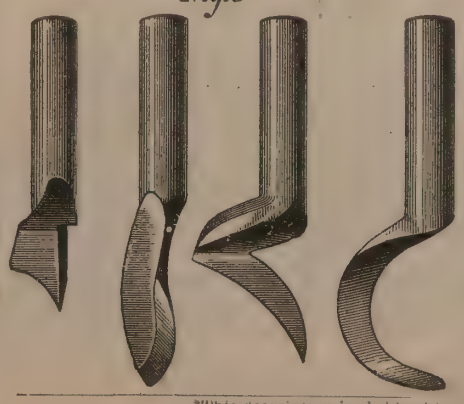
It will be obvious that any motion given to the tracer, *G*, will be at once followed by the cutting tool, *H*, so that, for example, if the tracer be moved about the edges of a certain curve, the cutter will follow a like path. The latter, however, will be reduced in size, though in exact proportion, on account of the cutter being located nearer the center of the circle of which the bar, *A*, is the radius, than the tracer. Since the sleeves to which the bars, *C* and *D*, are pivoted are adjustable, it is clear that the nearer the cutter is carried toward the shaft, *B*, the smaller will be the path it describes, corresponding to that moved over by the tracer; and therefore the object, the outlines of which are followed by the latter, may thus be reduced, to any less scale desired, by suitable movements of the sleeve of the bar, *D*, in or out on the rod *A*.

In the engraving, the machine is represented as carving the scroll work upon a pianoforte leg, which is mounted on centers so that the surfaces to be operated upon may be brought uppermost in succession. The work is always reduced in scale from three-fourths downward, so as to secure greater ease and accuracy in operation; and therefore the pattern, which is shown secured beneath the tracer, *G*, is considerably larger than the article itself, which is fastened beneath the cutter.

In order, to cause the tool to form the raised or indented portions of the work, it is necessary that there should be free movement in a vertical plane, so that, by continuous pressure on the tracer, the cutter may cut downward or to be raised to leave certain portions in relief. The bar, *E*, it will be noticed, is very much heavier in construction than bar, *F*. It thus serves as a counterpoise, and balances the frame on centers on the sleeves on bars, *C* and *D*, which surround rod A. The motion of the frame, therefore, is universal; and at the same time, the parts are perfectly balanced in every position, reducing the manual labor of moving it to a minimum. This is probably the most important improvement in the invention, and gives a large advantage over the ordinary routing machine, the motion of the cutter of which is confined to one horizontal plane.

Connected with the upper part of the tracer, *G*, is a small rack, with which engages a pinion operated by a hand wheel. This device is shown more clearly in Fig. 2. Its object is to control the vertical action of the cutter, so that, if desired, it can be prevented from making as deep an indentation as called for by the pattern, or just the reverse. In Fig. 3 several forms of the cutters used are shown.

Fig. 3



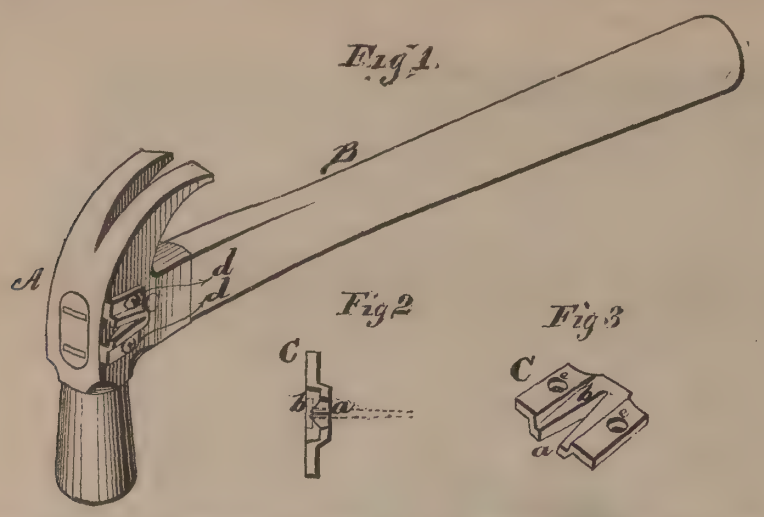
The capacity of the machine is large, since the table may be built on a more extended arc, thus admitting of an area to be worked over as great as is afforded beneath the cutter, allowing, of course, room for the pattern. The invention is light in all its portions, and easily constructed. It will prove, we think, a valuable aid to workers in wood of all classes, since it can be adapted to perform all kinds of carving, from the coarsest scroll work, or similar decoration used upon furniture to the engraving of wood blocks.

The inventor is Mr. John F. Blackman, corner of Fulton and Dutch streets, New York city.

*This description is abridged from "Scientific American," xxxiii, 95

IMPROVED HAMMER.*

Heretofore the nail-starter has been constructed with a hammer forming a component part thereof. In the invention the nail-starter is made separate and applied to the hammer so that it can be removed at pleasure. *A* represents an ordinary hammer attached to the handle *B*, and provided with screw-holes in one of its side faces. The attachment consists of a metal plate, *C*, having a slot, *a*, running nearly through the centre on top in the shape of a **V**. On the under side of the plate is also a slot or groove, *b*, extending on both sides of the slot *a*, as shown. Both of these slots are beveled to suit different sizes of nails. The slot *a* is beveled to suit the taper of the nail, and the slot or groove *b* to suit the different thicknesses of heads. The

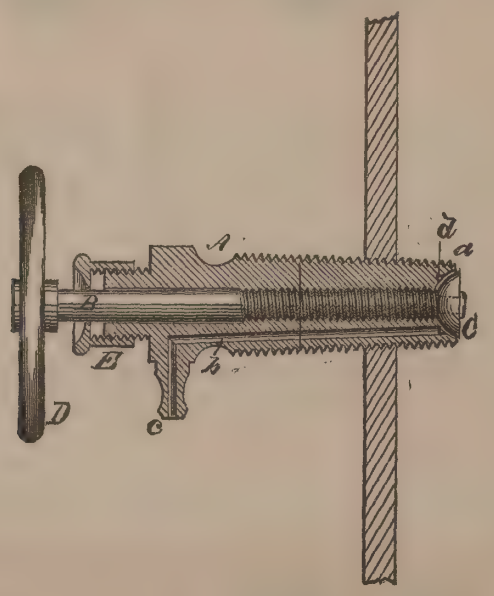


nail-starter or plate *C* is fastened by screws *d d* to the side of the hammer, as shown, the screws *d* passing through the holes *e* in the plate or nail-starter, *C*, and thence into the screw-holes in the side face of the hammer or hatchet. By this construction the nail-starter can readily be removed if broken or inoperative, and another substituted for it. The head of the nail is placed in this plate, resting on the side of the hammer. By this device a nail or tack may be driven in, even in such places where a person cannot hold the nail or tack in his fingers. It is necessary only to give a blow sufficiently hard for the nail to stick, then draw the hammer away from the nail, and the nail is left started ready to be driven in the usual manner,

*Patented August 7th, 1877, by Albert Knight, of Sandusky, Ohio

IMPROVEMENT IN GAUGE COCKS.*

"The invention consists of a gauge-cock for steam-boilers, the valve of which is within the boiler, and is opened and closed by a threaded spindle that fits an internal thread in the body of the gauge-cock. The internal thread and the thread of the spindle extend from the valve outward beyond the exterior of the boiler. A passage is provided in the body of the gauge-cock for the escape of steam or water, which is closed by the valve. The object of the invention is to provide a gauge-cock that will not allow the escape of hot water or steam if it should be broken off outside of the boiler-shell. *A* is the body of the gauge-cock, which is bored longitudinally through its centre, and threaded internally to receive the spindle *B*, upon which a thread is cut that fits the internal threads of the body *A*. The inner end *a* of the body is concaved to receive the convex valve *C*, which is attached to the end of the threaded portion of



the spindle *B*. The outer end of the spindle *B* is provided with a hand-wheel *D*, and is surrounded by a stuffing-box *E*, at the other end of the body *A*. A passage *b* runs lengthwise through the body *A*, the inner end of which terminates at the annular groove *d* cut in the valve-seat and is closed by the valve *C*, and its outer end terminates in a nozzle *c*. The body *A* is threaded externally and screwed into the boiler in the usual way. The internal thread of the body *A* and the thread of the spindle *B* extend from the valve and valve-seat outward beyond the boiler-shell, so that if the gauge-cock should by accident become broken outside of the boiler-shell the valve would be undisturbed, and the accidents that usualty follow the breaking of a gauge-cock entirely avoided. The stuffing-box at the outer end of the body *A* is not deemed essential, as little, if any, water or steam can escape around the spindle."

*Patented June 19th, 1877, by Henry Lee Borden, of Elgin, Ill.

AN EFFECTIVE SEWER GAS TRAP.

It is a matter of general knowledge amongst the well informed, that some of the greatest dangers that threaten the health of our cities, are traceable to the gaseous emanations from drains and sewers. The ingenuity of native invention has provided the American city dwelling with a host of conveniences, which are elsewhere comparatively unknown, as witness the almost universal introduction of illuminating gas, of hot and cold water pipes, communicating with bath room and wash stands in bed rooms, the connection of such devices and water closets with the sewers through which the waste water from the lavatories and kitchen, and the contents of the closets may be speedily and effectively removed, without offense to the senses, and without detriment to the health. These last named devices, while they contribute immensely to the comfort and convenience of modern city life, are by no means unalloyed advantages, but on the contrary, while, on the whole, they must be accorded the merit of having greatly improved the cleanliness of our cities, and, as a consequence, their general healthfulness, by doing away with the almost universal custom of permitting the foul waters of the kitchen and other more offensive matters, to find their way into the sewers, by way of the gutters of the streets, they frequently aggravate the many evils which they are supposed to check, wherever, from careless or defective construction, they permit the gaseous emanations of the sewer, those insidious carriers of contagion and death, to find their way into the very sleeping apartments of the occupants of the house "with every modern improvement."

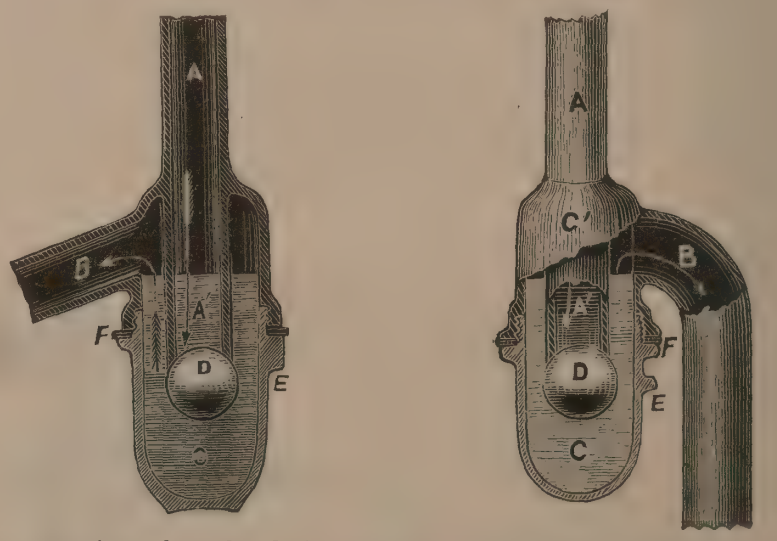
The danger arising from this source are so well known, that sanitary engineers and others have devoted much time, and develop much ingenuity in inventing traps and seals and valves, and a host of other devices, for the purpose of preventing the escape of sewer gases into the house. The commonest of these devices, in the ordinary S trap, which is simply a double bend in the waste pipe, that is designed to form a constant water seal between the sewer on the one hand, and the dwelling on the other. For a variety of reasons, however, this device is very imperfect. Most water seal traps are liable, if not regularly used, to lose their water by evaporation, in which case, they of course offer no hindrance to the free passage of the noxious vapors they were designed to arrest, or, where this circumstance does not occur, many of the simple water traps in use are liable to lose their water seal by siphonage, every time a basin, bath tub or water closet is emptied, and this may effect every other trap on the same line of waste pipe.

Again, the water seal trap, as commonly constructed, is only capable of resisting a pressure of a few ounces at most, and a variety of causes may bring an opposing pressure to bear upon it, greater than its power to withstand, and unseal it. This may be brought about, for example, by great volumes of water passing through the branch waste pipes; by the entrance of tide water into the mouth of the sewer, forcing back its contents, and creating a considerable back pressure (a strong and persistant storm of wind may produce the same result); or by the gradual choking up of the sewer, by the accumulation of solid refuse, while, if any of these conditions should coincide with periods of high temperature and low barometer, at which time the volume of unwholesome gases generated from the decomposing refuse is at its maximum, the danger of unsealing the water trap is therefore considerable. From one or the other of these causes, or a combination of them, therefore the back pressure brought against such traps may often be sufficient to unseal them, and to force into the dwelling considerable volumes of the disease-bearing sewer vapors.

It has also been urged, and we think correctly, that it is fallacious to trust to a water seal to oppose the transmission of such gases; inasmuch as the absorptive power of water for nearly all gaseous substances is considerable, and especially under pressure.

That the sewer gases are transmitted through a water seal, in variable quantity according to the circumstances (temperature, pressure, depth of seal &c.), being absorbed at the sewer end of the water seal, and given out at the house end, as soon as it has saturated itself, we think scarcely admits of doubt. Where the closet, sink &c., is frequently used, and the trap water therefore as often freshly renewed, the liability to danger from this cause is reduced to a minimum.

With these preliminary considerations, we will be prepared to pass judgment on the merits of the sewer trap shown in the accompanying illustrations, and which is claimed by its inventor (Mr. B. P. Bower, of Cleveland, Ohio), to be not only free from the grave objections above advanced against the common water seal, and all water seals in general, but also to possess special advantages, peculiar to itself.



The engravings show the device so clearly, that detailed description is hardly necessary, save to notice that the inlet pipe of the trap descends about half way down into the cup shaped chamber *C*, which forms the water seal, the shape of which chamber is such as to render it scarcely possible for it to be emptied by siphonage. The chief peculiarity of the device, however, is a floating valve, a hollow rubber ball *D*, which, while it permits of the discharge of the waste waters from the closet, sink,

&c., thereupon, at once seats itself, in virtue of its buoyancy, and the impossibility of its finding any other position of equilibrium, against the opening of the inlet pipe AA'. The utility of this simple device, and its superiority to the simple water seal are obvious, for the greater the back pressure brought to bear upon the trap from any of the above named causes, which frequently demonstrates the weakness of the simple water seal, the more firmly will the ball valve be pressed against, and the more firmly will it close the only opening through which the sewer gases can enter the house. The passage of sewer gas through the water seal, by absorption and emission, is likewise checked by the valve, which cuts off all communication between the water seal on the sewer side, and that on the house side, in the inlet pipe above the ball. While the water in the chamber C, next the sewer, may charge itself with the gaseous exhalations, that in A' remains unaffected.

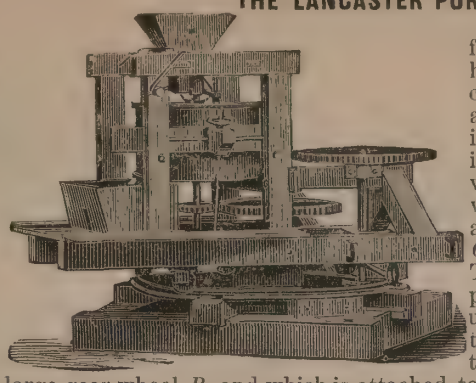
In addition, the following incidental advantages are claimed for this device: (1) that from the shape and position of chamber C, it cannot be emptied and unsealed by siphonage; (2) that it cannot become unsealed by evaporation, since the only free surface of the seal is on the sewer side, which is already fully saturated with moisture; (3) that from the scouring action of the ball, during discharge, the trap cannot become choked with sediment; (4) that the trap is not liable to burst by freezing, since the compressibility of the ball valve allows for the expansion during freezing; (5) the lower section of the water chamber is a glass vessel, so that the operation and condition of the apparatus may be inspected without difficulty.

To secure the full benefit of the scouring qualities of the trap, the makers state that it should properly be put in with a free waste, and that there should not be another trap between it and the sewer, unless ventilated between them. They give preference to the "Jennings" closet (or one similar in construction), in which a solid, weighted plunger is used to close the main discharge, the trap, in this case, being connected to an independent overflow. In conclusion we may add, that, while it is contrary to our usual custom to endorse patented inventions described in the columns of the REVIEW, we feel too strong an interest in whatever relates to household sanitation to permit so meritorious an invention to pass without commendation.

The trap is manufactured by Messrs. B. P. Bower & Co., 16 Frankfort St., Cleveland, Ohio, under patents issued April 24th, and Aug. 11th, Aug. 14th, 1877.

W.

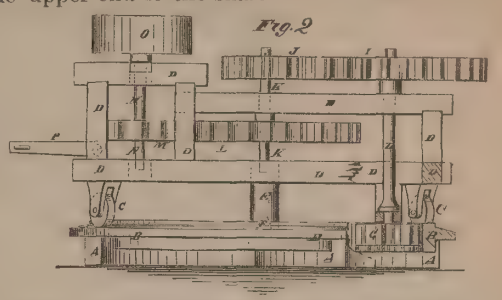
THE LANCASTER PORTABLE GRIST MILL.*



"The design of this invention is to supply for use upon the farm, a cheap and durable horse mill. It consists of a grist mill so combined with the horse power as to form a compact machine. As shown in Fig. 2, A is the base-frame of the machine, to which is attached an internally-toothed gear-wheel, B. The upper side of the gear-wheel B is made wide and smooth, to serve as a way for the small wheels or rollers, C, pivoted to the corners of the frame, D. To the centre of the frame D is attached a post, E, the lower end of which revolves upon a pivot, F, attached to the centre of the frame A. G is a small gear-wheel, the teeth of which mesh into the teeth of the large gear-wheel B, and which is attached to the lower end of the shaft H.

The shaft D revolves in bearings attached to one end of the frame D, and to its upper end is attached a large gear-wheel, I, the teeth of which mesh into the teeth of the small gear-wheel, J, attached to the upper end of the shaft K. The shaft K revolves in bearings attached to the middle part of trame D, and is attached to the large gear-wheel, L, the teeth of which mesh into the teeth of the small gear-wheel, M, attached to the shaft N. The shaft N revolves in the bearings attached to the frame D, and to its upper end is attached a grinding-mill, O, which is thus carried around by and with the frame D.

Fig. 2



The grist mill is similar to those worked by steam and water power—20 inch stones (French burr when preferred) being used. The horse power consists of ordinary spur gearing. The great advantage of this mill consists in the happy combination of mill and horse power. The power is applied direct, and not through the intervention of separate machinery, thus avoiding friction, saving power and economizing space. This mill can be worked by one or two horses, and yields five bushels per hour of fine meal or flour, with two horses.

It is simple and can be worked by any farm hand. It is so constructed that the stones can be easily dressed."

*Represented by C. C. Lancaster, 66 Broadway, N. Y.

NITRIC AND CHROMIC ACID BATTERIES.*

The most powerful voltaic combinations known are those in which some of the mineral acids are employed as excitants, especially nitric, chromic and sulphuric acids.

THE GROVE BATTERY.

This battery was, until quite recently, in general use in this country for working telegraph lines. It consists of a hollow cylinder of zinc, about three inches high and two in diameter, coated with an amalgam of mercury, and having an opening on one side to allow a free circulation of the liquid. The zinc cylinder has a projecting arm, to which is attached a strip of platinum about one inch wide and three inches long, and having the thickness of tin foil. The zinc cylinder is placed in a glass tumbler containing sulphuric acid, diluted with about twenty times its bulk of water. Within this cylinder is placed a porous cup made of earthenware, baked without being glazed, and filled with strong nitric acid. This cup allows liquids to pass slowly through it, and, when wet, offers but little resistance to the electric current. Within this cup is suspended a strip of platinum fastened to the end of the zinc arm projecting from the adjoining zinc cylinder. Fig. 12 represents a Grove battery, consisting of forty such combinations, each cell is completely insulated and arranged upon a stand. The stand has four girders and fifteen holes in each girder. In the holes are placed oaken pins, to which are attached glass insulators with wooden shields, the latter supporting the battery cells. The stand, pins and shields are well coated with asphaltum, and the glass insulators dipped in paraffine.

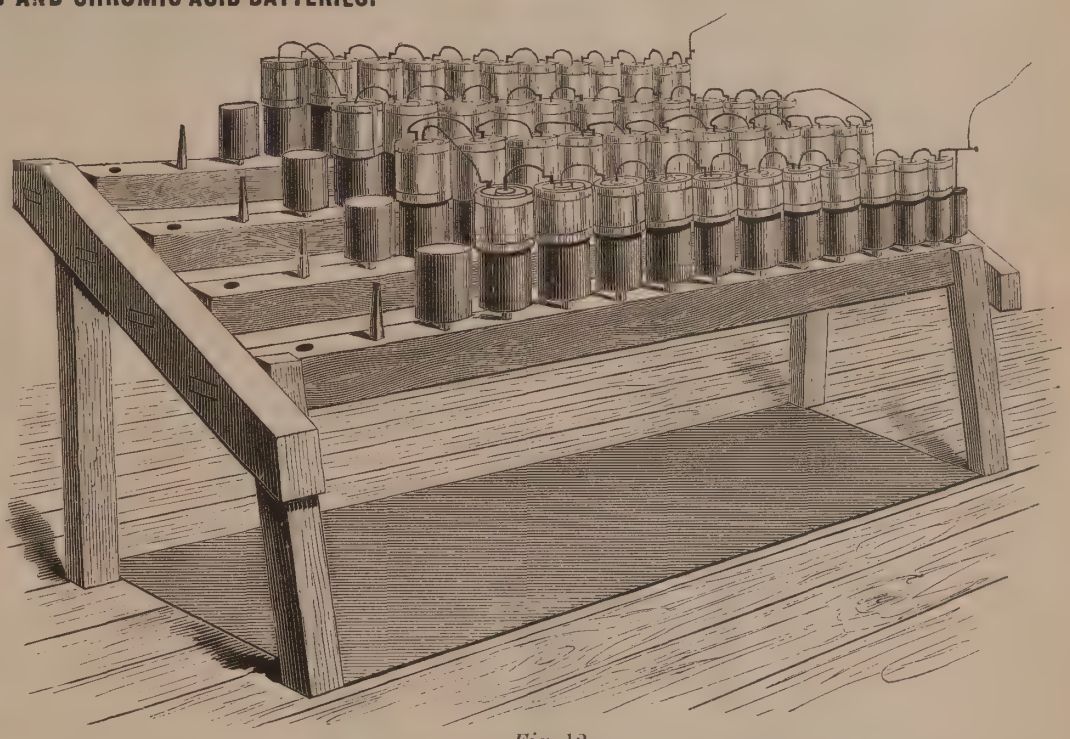


Fig. 12.

When the Grove battery is in action sulphate of zinc is formed in the outer cell, and the heavy brown gas, peroxide of nitrogen, is given off by the nitric acid. The peroxide of nitrogen discharged at the platinum plate is absorbed by the nitric acid, in which it is soluble, so that the plate is left free. The resulting solution is highly conducting. The peroxide of nitrogen soon spontaneously separates from the nitric acid, giving rise to the dark brown vapor already mentioned.

THE BUNSEN BATTERY.

The Bunsen zinc-carbon element replaces the expensive platina of the Grove battery by a mass of carbon made up in the shape of a hollow cylinder, peculiarly prepared.

Fig. 13.

Fig. 14.

Figs. 13 to 16 represent it in its parts and construction.

As will be seen from Fig. 13, a carbon cylinder, open at the bottom, is put in a glass vessel, which becomes narrower towards the top; in the hollow of the carbon cylinder is inserted a hollow, porous clay cylinder, closed at the bottom. A ring, a, is closely laid around the upper part of the carbon cylinder, extending beyond the glass vessel; this ring is attached to the hollow cylinder c, made of rolled zinc. Ring a is made of copper, and, as Fig. 14 shows, may either be closely fastened to the carbon cylinder at a, or by means of the copper cross-bow and the screw b, may be coupled to the zinc cylinder at pleasure.

The porous clay cup, which stands inside the carbon cylinder, is filled with diluted sulphuric acid, and the glass vessel in which the carbon is to be found, with concentrated nitric acid. Zinc cylinder c, of one of the elements, hangs in the porous cup filled with sulphuric acid of the next element. How these separate elements are connected into a battery is shown in Fig. 15.

Fig. 15.

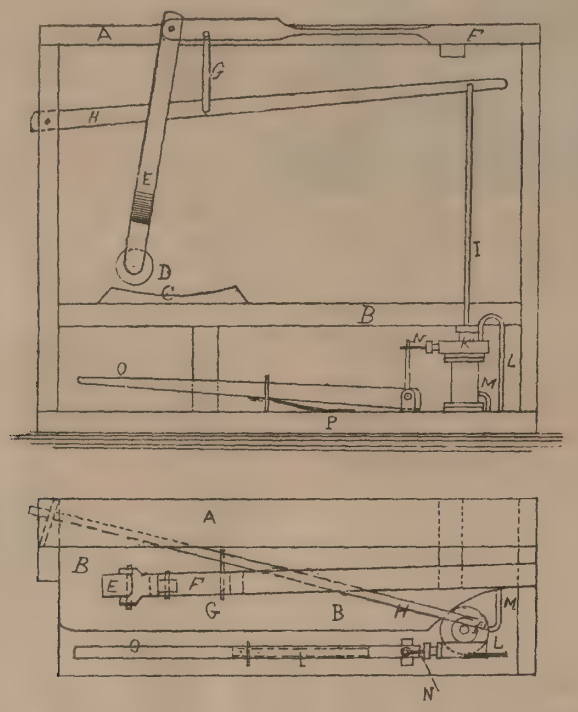
The zinc cylinder of the first glass is connected with the copper strip or the carbon cylinder of the second glass, the zinc cylinder of the second glass with the copper strip of the third glass, and so forth. Finally, the zinc cylinder of the last glass, with its strip n, projects out of the battery and forms the — pole, just as the copper strip p of the first glass forms the + pole. The positive current passes in this battery, in the closing wire, outside the fluid, from carbon to zinc.

*From Prescott's Electricity and the Electric Telegraph.—D. Appleton & Co.

IMPROVEMENT IN LEATHER ROLLING MACHINES.*

The accompanying engraving illustrates a lately invented steam-pressure roller for rolling leather, Figs. 1 and 2 being respectively the vertical and horizontal projection of the same.

A represents the frame of the machine, *B* the table, and *C* the concave block upon which the roller works. *D* is the roller which is pivoted to the lower end of the swing-



ing bar *E*. The upper end of the latter is pivoted to the free end of a spring bar *F*, which is attached to the frame *A*.

To the spring bar *F*, at a short distance from the free end, is pivoted a connecting rod *G*, which is elevated or depressed by the lever *H*, which in turn is operated directly from the steam cylinder by means of the rod *I*. The whole operation of the machine depends upon the depression by means of the foot of the bent lever *O*, which, in connection with the valve stem *N*, opens the valve passages in the chamber *K* and admits steam to the cylinder, which, by depressing the piston, draws down the beam *H*, and consequently *F*, and the roller *D* is pressed forcibly upon the leather to be rolled. On removing the foot, the spring *P* raises the lever *O*, closes the inlet and opens the exhaust, and the roller will be raised from the work.

*S. McVitty, Saltillo, Pa., Ag't.

IMPROVEMENT IN CAR-STARTERS.*

"*A* designates a wheel, provided with a flange, *a*, and cogs, *b*, upon its outer edge. *B* designates spring-pawls, attached to the cross-bar *C*, which catch into the cogs *b*. The cross-bar is attached to a horizontal beam, *D*, and travels in apertures cut in the bars *E*, which are secured to the bottom or the car. Upon the ends of the cross-bar are brake-blocks, *F*, which engage with the wheels in the ordinary manner. The

Fig 1.

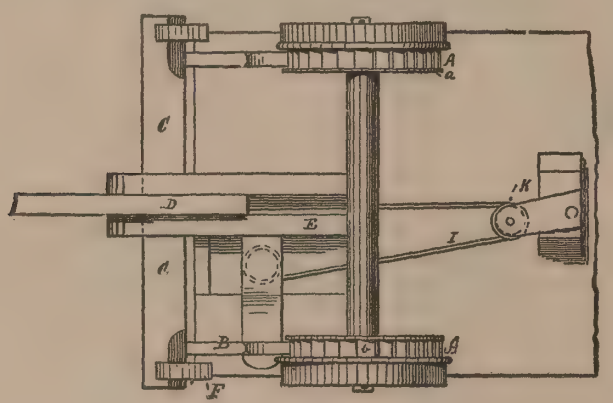
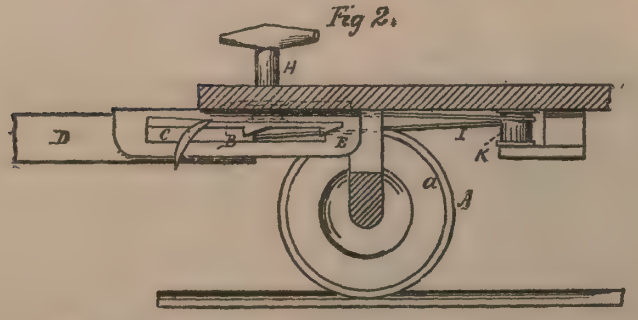


Fig 2.



cross-bar is moved in such a manner as to force the brake-blocks against the wheels, and cause the spring-pawls to engage with the cogs by means of the windlass, *H*, which operates the chain *I*. The chain is wound over the pulley K, and is attached to the rear end of the beam *D*. When the beam is started, the forward movement of the beam causes the spring-pawls to force the wheels forward."

Patented May 1st, 1877, by Daniel Shoup, of Warsaw, Indiana.

THE MANUFACTURE OF KNIVES.

In forging table knives two workmen are usually engaged, one of them controlling the piece under treatment with his one hand, while with the other he does all the light work, with the aid of a small hammer, his assistant dealing only the heavier blows. In this way the end of a red-hot bar of steel rapidly assumes the form of a knife blade, and is separated from the rest of the bar, leaving, however, enough material to furnish the tang of the knife, the part which is secured in the handle, though this is sometimes forged from a piece of iron welded to the steel blade.

The elevated portion of the knife between the blade and tang is formed at the same time by the use of the proper mould. A second heating and hammering completes the smith's share in the work. In France where the knife manufacture has been carried to a high degree of perfection, a method of rolling the knife blanks has recently been introduced, producing excellent results.

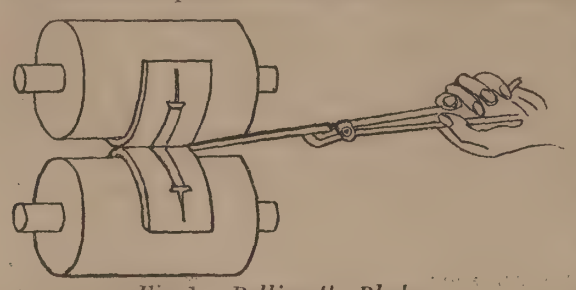
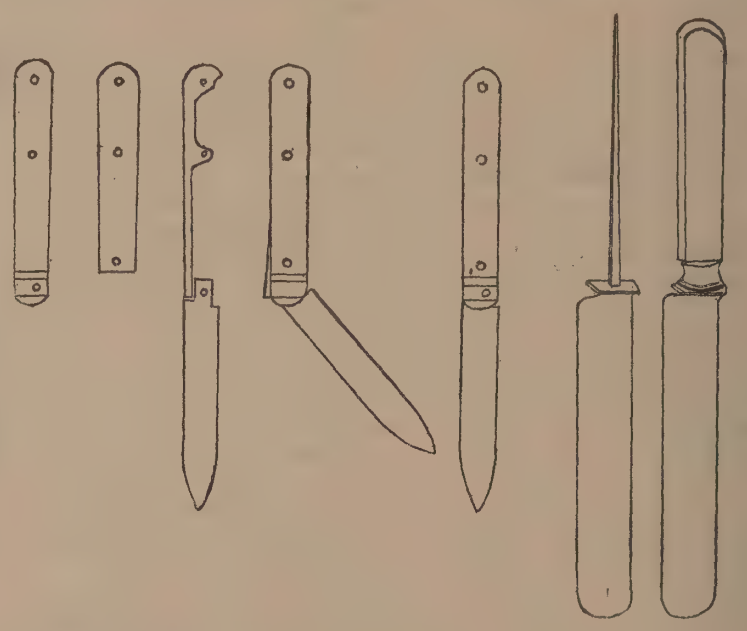


Fig. 1.—Rolling the Blades.

After having been properly hardened and tempered, the knives pass finally into the hands of the grinders and polishers. The tangs of table knives are either flat or pyramidal in shape. The flat tangs are placed between the two halves of the handles, and are secured therein by means of several small rivets. The four-sided tapering tongues have a hole drilled for them in the hafts, and are firmly held in place by a cement composed of pitch and brick dust: in the case of knives with metal handles by pouring in molten lead.

Blades for pen and pocket knives are forged in a similar manner from small bars of steel. Their further elaboration—drilling the hole and cutting the notch along the back—is performed after a second heating. In tempering the blades after having first hardened them, they are placed upon an iron plate with their edges uppermost, and heated until they assume the right shade of color.

The accompanying illustration, Fig. 2, represents the more common form of table knife together with an ordinary clasp knife, and its separate parts. Pocket knives are composed of three principal pieces—the blade, the spring, and the haft. The haft is formed of two thin metallic plates, both covered on one side with small sheets of horn, ivory, bone, or other similar material. The blade turns about a small rivet in the upper part of the handle, and bears with its lower extremity against the spring, which is fastened at two places to the back of the handle, as shown in the engraving.

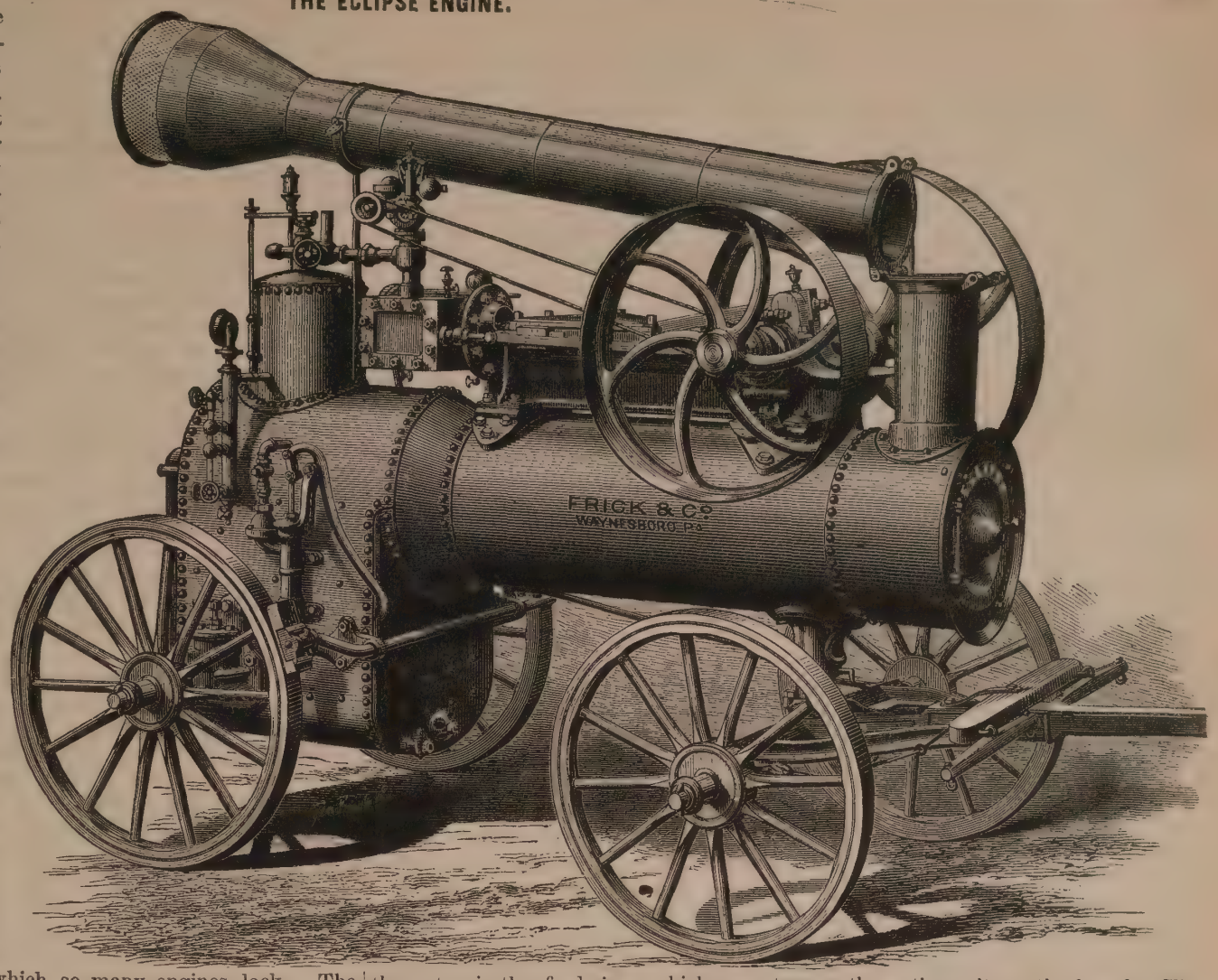


Razor making demands special care and attention on the part of the workman. A high grade of steel, a proper degree of hardness, and a very fine cutting edge are the essential requirements of such an instrument. The blades are forged from the flat bars of cast steel as thick as the back of the razor, and the operation is usually carried on by two workmen upon a slightly curved anvil. They are never heated above a dull red heat, in order to prevent any deterioration in the quality of the steel, so that ten or twelve reheatings often become necessary before they are ready for their next stage, their hardening. They are heated, as in the case of the pocket knives, on an iron plate to a bright cherry red heat, and are then thrown, back foremost, into a large vat full of water, into which they are stirred about until perfectly cold. In tempering, the blades are heated in an alcohol flame or in a bath of a molten mixture of tin and lead until they acquire the proper tint of yellow, which varies a good deal with the quality of the steel employed and is only to be learnt by experience. Grinding and polishing conclude the process.

An improved method of making razor blades has lately been patented in England, consisting in stamping them from thin sheet steel and riveting two strong narrow strips upon them, in order to form the back. This process greatly facilitates the manufacture of razors, and is advantageous in more than one respect.—*Scientific American*, xxxvii, 88.

PINES and firs have been discovered to have a greater effect than other trees in influencing the rain-fall and increasing the general humidity of the atmosphere. This same fact may possibly be utilized with advantage on some of the Western lands in this country.

THE ECLIPSE ENGINE.



Though the industrial application of the steam engine dates as far back as our Revolutionary troubles, it is but quite recently that its use has been extended to agricultural operations. The increased scale on which agriculture is at present carried on, has necessitated greater power than that capable of being furnished by animal labor, and has therefore called into existence a new class of steam engines to meet this demand. These engines must necessarily combine efficiency of action with such simplicity in construction as not to be liable to derangement even in the hands of unskillful persons, and should be strongly mounted on a truck so they may be readily moved from place to place as necessity may demand. Special attention should be paid to the solidity of all the parts, since the localities in which the engines are most needed are generally far removed from repair shops.

The engine herewith illustrated is the so-termed "Eclipse" engine, made by Frick & Co., of Waynesboro, Pa. Besides being compact and simple in construction, with all its parts easy of access, it comprises many features for which the company claims advantage over other engines of its type. The cylinder-head, guides and the bearings for the crank-shaft are cast in one piece with the bed which forms the support for the working parts, and which is bolted to a saddle-piece on the top of the boiler. Since the cylinder is bolted to the bed at one end only, it is allowed perfect freedom of expansion, and, on account of its being removed from the boiler, is not subjected to the strain incident upon the greater expansion of the boiler, as is the case with those bolted directly to the same. The pillow-blocks and cross-head are supplied with adjustable screws and gibs by which all wear can be compensated for, a requisition which so many engines lack. The crank-shaft admits of a pulley being placed at either end. The piston has a self-adjusting metallic ring and a rod of steel. The heater consists of a large cast iron pipe bolted near its one end to the steam cylinder, and is supported at the other by a bracket forming part of the bed. The advantage of this piston is that the extremes of heat and cold to which the heater is subject, cannot affect the engine in any way; while if the heater were formed as the bed, the consequent expansion and contraction would be likely to throw the working parts out of alignment. The exhaust steam from the cylinder passes through this heater on its way to the smoke-stack, heating the water in the feed-pipes, which pass two or three times its entire length. The disposition of the other parts are easily seen in the illustration. The boiler is of the common locomotive type, and apparently possesses no novel features, unless it be the rounded fire-box, which prevents the accumulation and adhering of sediment in the water space which surrounds it. The hand-hole at the bottom is well placed. The smoke-stack is hinged so that it can be laid down in case of transportation or storing. The spark-catcher, with which the stack is supplied, is an essential part of all the engines of this class.

O. C. W.

MINERAL ACIDS, METALLIC SALTS AND CERTAIN OTHER SUBSTANCES CONSIDERED AS DISINFECTANTS.

In several articles that have preceded this, the disinfecting qualities of the chloride of lime, the sulphate of iron and the permanganates, are described in order, and the circumstances under which each could be advantageously applied were designated. Before taking up the description of certain important organic compounds which are possessed of valuable properties in this connection, it will be well to first dispose of a number of mineral compounds that are occasionally called upon to serve the purposes of disinfectants.

Of these, the mineral acids, such as sulphuric and hydrochloric acids must be mentioned. These substances have no hygienic virtues, but by effecting certain chemical changes, when brought in contact with matter in process of decay or putrefaction, they have a limited usefulness as chemical disinfectants or deodorizers.

The usefulness of these acids, it may be added, depends almost exclusively upon their ability to combine with and to convert the pungent ammonia and carbonate of ammonia into fixed and insoluble combinations—sulphate and chloride respectively—but they do not act upon the very offensive sulphuretted hydrogen, and when added to cesspool or other accumulations of refuse in wells, &c., may exert a damaging influence upon the materials of the wells or reservoirs, corroding or dissolving them in places, and thus permitting the escape of their offensive contents, and its percolation into the adjacent soil, a state of things that may be followed by grave dangers to health.

On the other hand, the addition of acids to such accumulations, decidedly improves the fertilizing qualities of the refuse, by binding in fixed form its ammoniacal constituents. The sulphate of iron, the properties of which were discussed in a previous article, when added to such refuse, not only binds the ammonia quite as effectively as either of these acids, but decomposes and binds in inodorous forms the very offensive sulphuretted hydrogen which they (the acids) will not affect. The sulphate of iron, in contact with such refuse, effects a double decomposition, the iron breaking up the volatile and offensive sulphurous compounds, forming an insoluble sulphide of iron, leaving the equivalent of sulphuric acid, which is thus liberated to seize upon the ammonia and convert it into the stable and odorless sulphate. The liberation of acid from the sulphate of iron during its operation is so gradual, and its neutralization by the excess of ammonia present is so instantaneous that it cannot exert any injurious effect upon the materials of the reservoir. As regards the effect of the action of the iron salt upon the fertilizing qualities of the refuse, we have shown that it is very favorable. On the whole, therefore, these comparative considerations will have made it evident that the sulphate of iron will act the part of a deodorizer far more effectively than mineral acids, while it is free from the incidental objection of endangering the materials of the reservoir, or well, by corrosion. As regards the cost, the difference lies in favor of the acids, but as this is in either case trifling, we may conclude that the employment of mineral acids for deodorizing or putrefying masses is not to be recommended where the sulphate can be readily obtained. For general hygienic disinfection, the acids are, as indicated at the outset, quite unfitted.

Certain salts of the metals, especially the chlorides (or sulphates) of alumimum, mercury, copper and zinc, possess the peculiar property of preventing the putrefaction and decay of vegetable and animal tissues by virtue of a peculiar quality that they possess, of coagulating the albuminous portions thereof and by thus rendering it insoluble, arresting for a time the process of decomposition. These compounds, without doubt, in virtue of this property, possess a notable hygienic value; but in estimating their comparative worth we are led to the conclusion that their utility as disinfectants is quite limited. Their action upon albuminous matters, if we except, perhaps, the salts of mercury, is by no means so energetic as that of another rival, carbolic acid, (to be subsequently treated of), they are not volatile at the ordinary temperature as is the disinfecting element of the chloride of lime, (previously described in detail), and therefore cannot exert a purifying influence upon the surrounding atmosphere. As hygienic disinfectants, therefore, they are inferior in general utility to the chloride. From the chemical standpoint, they may be said to act in a manner analagous to the sulphate of iron, when brought into large accumulations of decomposing refuse, such as the excreta of men and animals, the process being the fixation of the ammonia as chloride or sulphate, and the formation of an insoluble metallic sulphide; but the cost of the salts of these metals is so considerable as compared with that of the sulphate of iron, as to place the question of competition with the latter as a deodorizer for eesspool and similar accumulations beyond consideration. The virtues of these metallic salts, therefore, may be summed up to reside in their antiseptie property—that is, their power to prevent or to retard the putrefactive process in bodies susceptible of it. For purposes of general hygienic and chemical disinfection they are unsuited.

Unslacked lime may and often is employed with excellent effect to hasten the destruction of and to suppress offensive exhalations from putrefying animal matters. It seizes with avidity upon the moisture contained in the animal tissues, absorbs ammonia and unites with the sulphur, carbonic acid, &c., liberated during the decomposing process. When freshly slacked and applied to walls, it frees their immediate surroundings of deleterious gases and offensive odors by its chemical influence. The utility of lime, therefore, as a chemical disinfectant, when applied to small accumulations of pntrefying animal matter, or to walls of cellars, outhouses, &c., it is to be recommended. As an addition to cesspool accumulations, the quantity of material that would be required to exert the proper effeet renders it unsuited.

Finally, to close this branch of our subject, we may add that dry earth, charcoal, peat and similar absorptive materials are extensively used as disinfecting agents, to be strewn in the neighborhood of decaying or putrefying matter, or to be employed in connection with closets and similar devices that are growing in favor as substitutes for the objectionable and barbarous well system in general use; and though these substances exert a mechanical, rather than a chemical action, in the suppression and retention of odors and the dissociation of the refuse, their use may be highly recommended although when used in closets the frequent removal and renewal of the contents must be provided for. The fertilizing qualities of the product are perfectly preserved.

W.

ASBESTOS.

BY C. E. FOSTER.

Asbestos is a fibrous mineral, a variety of *hornblende*, the name being of Greek origin, meaning inconsumable. The finer quality is termed *amianthus*, also from the Greek, meaning undefiled, and well expressing the usnal absolute whiteness and purity of the substance.

The mineral sometimes occurs in the form of solid blocks, which may be split and broken until the individual fibres are separated, sometimes almost completely disintegrated in a flocky or pulverulent condition,and again as soft, pliable cords or strings resembling loose cotton yarn. The color varies from a dark dirty yellow to a dazzling whiteness, tinged, generally, with green. In these forms asbestos is widely distributed, being found in almost every portion of the globe. The finest qualities are obtained in great abundance in Corsica and Tuscany; in the United States, the mineral is extracted in considerable quantities from deposits at Staten Island, New York, in Pennsylvania, Maryland and elsewhere; there are also large deposits in Canada. The fibres of asbestos vary in length and appearance—some resemble spun glass, are smooth and unctious to the touch and readily subdivided under pressure, forming a soft, light, flocky mass. Others more nearly resemble flax, and are the strongest, but were generally discarded on account of the color and the presence of foreign particles until means were discovered of rendering the strong, dark fibres as soft and colorless as those of fine natural *amianthus*. This has been practically effected under Rosenthal's United States patents of 1872, covering an alkaline treatment. Hyatt's English patent, No. 478, for 1874, describes a treatment by hydrofluoric acid for a like purpose, and for the separation of finest particles to form a pulp.

Knight's Dictionary alludes to the use of asbestos by the ancients as follows: "Herodotus refers to cloth made of it by the Egyptians. Its uses for paper, napkins, socks, drawers, handkerchiefs, are referred to by Varro, Strabo and Pliny. Marco Polo mentions it, and Babtista Porta speaks of its being spun in Venice. Asbestos cerements and wrappings for the bodies of the dead previous to incremation were in common use with those whose circumstances permitted it. Shrouds of asbestos of the time of the Roman Emperors have been discovered, and are in the museums of the Vatican and of Naples."

Notwithstanding this early use of the material, its continued application to the present time, and its well-known refractory and lubricating properties, but little concerning it can be found on record beyond such brief mention as the above in cyclopædias, and somewhat more specific, but isolated descriptions in numerous patents.

It is, perhaps, due to this cause that patents have been issued for special applications of the substance which a thorough search shows to be lacking in novelty.

One of the earliest of the more modern recorded applications of asbestos was to the manufacture of incombustible paper, a specimen of which we find in an old German work, by Schaeffer, in the Library of the U. S. Patent Office. Such application is also specified in English Patent, No. 1413, for the year 1853, which states that the mineral must be boiled, the fibres divided, combine with alum and made into sheets. Subsequent efforts made in this direction vary but little in mode or effect from the earlier attempts.

The applications of the paper-board made of asbestos, and of asbestos compositions, have been various. The most common, as well as one of the most practical, has been to the covering of boilers and other surfaces, to prevent the radiation or conduction of heat. Hale and Wall's English specification, No. 1344, for 1861, describes the coating of stone and metal with a plastic composition of asbestos, pumice stone, muriate of soda, manganese and bone ash.

W. Peters, U. S. patent of January 21, 1862, reissued in 1875, claims the combination of asbestos and vegetable or animal fibre—the application of asbestos to joints,and a compressed asbestos packing. A subsequent patent of Peters', dated August 26th, 1862, describes the application of sheets of asbestos composition to boilers, pipes, etc., and the mode of securing it by bands or wires. The reissue of this patent in 1875 is made to cover broadly the application of combined asbestos and animal or vegetable fibre to pipes or other surfaces.

In 1868 a number of patents were secured in the United States for the application of asbestos, either as a paper, in sheets or blocks, or in a composition to boilers, sheathing and roofing. Of these, Johns obtained a patent April 14th, covering a roofing material composed of asbestos, pitchy matter, slate marble dust, clay, etc.; a subsequent patent Sep. 1st, is for a sheathing of asbestos felted with wool, or combined with paper pulp and waterproofed. Two sheets were secured with an intervening layer of asbestos, the sheet to be placed next to the boiler, being composed largely of asbestos and clay or other earthy matter. A roofing cement patented to J. A. Moore, July 21, consists of clay, plumbago, coal, asbestos and earth mixed with gas tar. A patent to J. L. Kidwell, Sept. 22, covers the coating of a roof cement, after its application with asbestos.

October 27th Selden & Kid patented a boiler covering of wire cloth supporting asbestos and clay, or earthy materials. Sept. 14, 1869, W. A. French patented a boiler and pipe covering of asbestosand alkaline silicate. E. S. Hardy, Sept. 14, 1869, patented a boiler covering of asbestos, cement, paper pulp, silicate of soda and soapstone. Jan. 4, 1870, S. Whitmarsh patented a flooring of linseed meal, rosin, asbestos, clay and other materials.

John Riley, May 9, 1871. patented a composition for boiler covering, safe filling refrigerators etc., consisting of asbestos, lime-putty, charcoal and pumice stone, or their equivalents, or of asbestos and lime-putty or its equivalent alone. In a suit instituted under this patent it was decided that it was infringed by a composition of clay and asbestos.

Hyatt's English specifications of 1873-4, before referred to, very fully set forth the manufacture of asbestos into sheets, felts, compositions or blocks for covering boilers, roofs, floors, for making fire screens, fire place blackings, shades and caps for lamps, boxes, envelopes, and articles of a similar nature, and frames for holding glass for pavement lights. As a wick for lamps the application of asbestos is probably much older than its use for paper, but the first modern description appears to be that in the English patent, No. 2071, for 1853, which is followed by others of a similar character. Thus in the English patent 145, for 1857, a woven lamp wick of silk and asbestos is described, and patent 2647, for 1855, sets forth the mode of braiding asbestos fibre in a machine, weaving it and felting it to produce wicks flat or circular. Sutherland's U. S. patent of Jan. 28, 1873, covers a wick treated with silicate of soda and asbestos. The fibrous nature of the mineral and its refractory qualities early suggested the possibility of making a woven incombustible fabric. Tomlinson's Cyclopœdia states that the art of weaving asbestos was anciently accomplished by weaving fibres of flax with those of asbestos, and then destroying the flax by heat: and the English patent, number 2,647 for 1855 before referred to, describes the manufacture of woven cloth from the asbestos alone.

Hyatt's English patents, Nos. 3,256, 3,684, and 4,241, for 1873, describe fabrics or nets of chendelle made of asbestos fibres, supported by cords, or cores of wire, hemp, horse-hair, etc.; the making of asbestos cords by squeezing a pulp through small holes; the pulp consisting of fine clay or lime-putty and asbestos fibres.

The first description of the application of asbestos as a packing for joints, pistons, and other purposes is found in Isaiah Jennings' U.S. patent, for a steam engine, dated Feb. 11, 1828. This also specifies the preparation of asbestos by making it into fibres similar to flax or cotton, to be packed round pistons, and the making it into gaskets, like hemp gaskets.

The specification for A. Drake's patent for an explosive engine, dated April 18, 1855, also refers to the use of asbestos as a packing.

Morris Botticher's, U. S. patent, of Oct. 4, 1864, refers to the use of loose fibre in packing, and Steven's patent of March 29, 1870, covers the insertion of a cord in asbestos packing to strengthen it.

Hyatt's English patent 3,256, for 1873, proposes a packing of the chenelle before described, and his patent, 4,241 describes a packing of pure asbestos fibres confined by and protruding through a wire net so as permit only the contact of the fibre with the friction surface.

Compositions including asbestos, for the manufacture of fire bricks and building blocks, form the subject of numerous patents; one is English patent, 13,059, for 1850, the manufacture of retorts, fire bricks and other articles of covering asbestos and fire clay. Laubereau's English patent, 213, for 1859, also describes a furnace lining of refactory clay mixed with asbestos, and English patent, No. 2,318, for 1862, specifies a mixture of asbestos, crushed fire brick, fire clay or plumbago, for making sundry articles, W. Peters' U. S. patent, of Aug. 12, 1862, is for a fire brick, composed of asbestos, clay, sand, soapstone and other earthy materials; and in 1868, A. Pelletier obtained patents for artificial stone, composed of soapstone, oxichlorides, litharge and mineral matters, one or more, combined with asbestos and with silicate of soda. S. Whitmarsh obtained a patent, July 7th, 1868, for a composition of asbestos, earthy matter and blood. Hyatt's English specification, No. 3,124, for 1871, describes a filling for buildings of asbestos combined with cement or plaster of Paris and alum.

M. T. Hagen, Dec. 10th, 1872, patented a stone made of cement, quartz, asbestos and sand.

In 1873, Vanzandt and Tartiere patented a building-block of plaster of Paris, sawdust and asbestos, and 1873 and in 1874, J. J. Bartlett obtained several patents for artificial stone in which asbestos was combined with mineral matter, cement and an alkali solution, the block being subsequently treated with muriatic acid or with chloride of lime.

Many of the asbestos compositions referred to in the above named patents for special applications, are well adapted to other purposes; thus, a composition patented for coating boilers, would answer equally well for roofing or for moulding various articles, and it needs only a slight inspection of the list to show that some of the patents granted under special applications cover only what was long before patented or described for other purposes.

The lubricating qualities of asbestos have been taken advantage of by employing the same for bearings, the earliest mention being found in English patent 2048 for 1853, for a lubricating composition of quicksilver, fats, oils, and asbestos. M. Botticher's patents of October 4, 1864, covers a combination of asbestos, soapstone and cotton. W. Peters' patent July 22, 1862, specifies a composition for coating bearings, of asbestos, vegetable or animal fibre, and plumbago. P. S. Devlan's patent of Aug. 22, 1865, describes a composition of lime, plumbago, silicate of soda and asbestos. A composition of asbestos, plumbago and wire filings is covered by P. J. Kelly's patent of Nov. 8, 1870; Hyatt's English patent 3,684, for 1873, specifies a composition of asbestos and grease, and his English patent 4,142, for 1873, a bearing of asbestos and fusible metal.

For many years it has been common to use asbestos to support articles of porcelain in the furnace while "burning" and to combine the mineral fibre with plaster of Paris in making moulds and other articles. English patent 362 for 1865 refers to the use of asbestos combined with rosin as an electrical insulator, as does Hyatt's patent, No. 3, 684 for 1873, Marr's English patent 6,555 for 1834 describes its use for safes, and indicates the purpose to combine it with clay, pumice stone &c. Bassett's U. S. patent of Mar. 4, 1862, sets forth the availability of asbestos as an absorbent for carburetters in a compound of coke, sawdust, coal tar, asbestos and pumice stone. Knight's dictionary refers to its use as a heat absorbent in gas stoves. Hyatt in 1869 patented the application to safes; and his U. S. patent dated in 1870 describes a refrigerating car in which asbestos was the non-conducting filling as in Rileys' patent of May 9, 1871; and Wm. Beschke Aug. 14, 1866, applied it to lamps to absorb the oil and prevent its distribution in case of fracture of the reservoir.

G. F. J. Colburn July 23rd, 1867, obtained two patents for a composition for plates of artificial teeth of combined asbestos and oxide of zinc, or asbestos, oxide of zinc and other materials. Whitmarsh's U. S. patent of 1870, specifies various uses of the composition before named, as for piano keys, vessels, panels, etc.,the material being baked to harden it.

Other applications and uses are specified in the various patents of Hyatt before alluded to as for glass moulds, moulded into bearings, for journals, window-shutters, slats and shingles, tips for gas burners, pressed into blocks for water-filters, combined with clay for tiles, stiffened with mucilage into a cord for making pile fabrics; supported by a net or metal frame or backed with rubber, leather, etc., for use in rugs, carpets, bearings, roof covers. Moulded under great pressure to make lathing-sheets

etc. Made into compositions as a paint or coating for wood or iron work, protected by a metal facing as an inside non-conducting lining for hot air or steam cylinders: as a a book binding, book case, sad iron handle; as a substitute for hair in mortar; as a fire proof glaze for paper; combined with gelatinous silica for artificial stone; as a packing around the edges of safe doors; as a felt, combined with other fibres.

Numerous as are the published applications of this peculiar substance, the great diversity of these applications and the proof that they adduce of the general knowledge of the characteristics of the mineral, indicate that much has been done of which there is no record, while the casual manner in which reference is made to the mineral in most instances, as subordinate to other matter, renders it highly probable that many facts are on record which have escaped observation, and will be brought to light only by accidental discovery.

There are comparatively few reliable data as to the practical results of the various applications mentioned; As matter not of record but within the knowledge of the writer it may be stated that where compositions of asbestos and more perishable substances are used, in friction packings etc., the perishable material as hemp, wool, etc., will in a short time burn away, leaving the asbestos, and that when the fibre is subjected to pressure and friction or is short or rotten, it soon breaks into a useless powder. The long strong fibre resulting from Rosenthal's process, the plaited fibre similar to Jenning's, and some others of the rope fibres have proved to be more practicable; but in most cases the harsh matter in the asbestos must be extracted to prevent the cutting of the friction surfaces.

Under the action of a high degree of heat the mineral loses its greenish tint and fine lustre and becomes yellowish and opaque and apparently looses its fibre so that it will pulverize readily between the fingers; the dust, or powder having the feel of fine kaolin.

Appleton's Cyclopedia contains an account of practical tests of asbestos clothing for firemen, made in Paris. The capacity to ward off flame was demonstrated, but the material soon became hot and unbearable. At the present time the practical applications are to roofing made of paper, covered with asbestos, under Johns' patents in New York, to sheathings and packings made of a heavy and very superior board, imported from Italy, a similar board, as well as loose material for boiler covering, etc., being prepared and sold under Rosenthal's patents in Philadelphia; to packing made in Boston under Steven's patent, and to quite a number of compositions and preparations made mostly in the Eastern States, under no special protection.

Washington, D. C., Oct. 1, 1877.

LATHE-CUTTER HOLDERS.

The shape and variety of slide-rest tools for hand and power lathes are almost infinite, varying according to the nature and hardness, size and shape, &c., of the material to be cut, and also according to the nature of the cut to be taken and the finish desired. And yet we do not find that increased superiority over the old work of the hook and heel tools, which we would expect, and the reason lies very largely in the mode of attacking the metal. The ordinary slide-rest (in fact most of the *best* slide-rests have the same fault) does not permit of the same range of angle and action which the heel-tool gave. Excessive hook or rake bring a tool down to a proper cutting position, but are not desirable; and even if they accomplished the desired end, the mass of metal which has to be forged or ground to shape, size and angle at each desired change, make the common tool a wasteful and unsatisfactory affair—unsatisfactory because it is impossible to have on hand tools suited to every grade of work, and so very often the "nearest best" tool is used; wasteful, because in making or

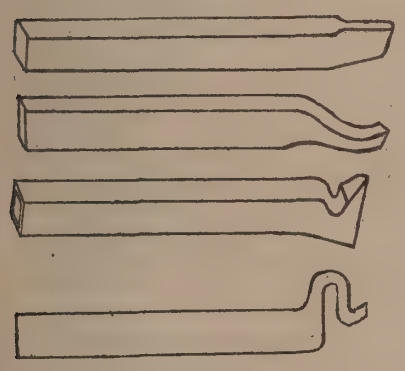


Fig. 1.

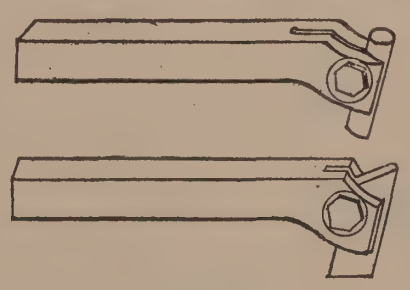


Fig. 2.

altering a tool we have time of latheman and forger or grinder lost, and steel used up unnecessarily. It may take a dollar's worth of steel and time to get up a tool for a job on which there is but ninety cents profit, and another dollar's worth to get the tool back again to first shape. The cutter-holder, (first suggested by Mr. Babbage), enables one to have a cutting edge at any desirable angle of presentation, and of any section, size, temper, side-angle and rake, without much expense for costly tool steel; and a large assortment costs but little; furthermore in making a change the time and material lost under the old system are saved. The holder may use steel of an inferior quality, and the tools are very much more ready sharpened. For instance, the ordinary diamond-pointed hook-tool must be carefully forged and tempered, and ground on the top and two sides. It may be readily substituted by a short piece of steel, triangular in section, ground on its upper face only. As the tool gets worn away in sharpening, there is no necessity of adjusting the height of the rest. The position of the tool is more favorable for ordinary traversing or surfacing, and it may be used as a side tool, if desired. The cut shows the ordinary bar-tools, and three forms of cutters. Mr. Ford Smith, of Manchester, England, has experimented largely with loose cutters, and find that when the depth of the cut does not exceed half the diameter of the cutter, a circular section gives better results and smoother work than where an angular section is used; and for very deep cuts he adopts an oval section.

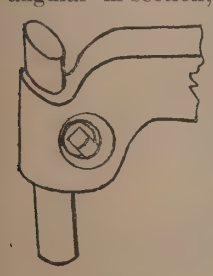


Fig. 3.

G.

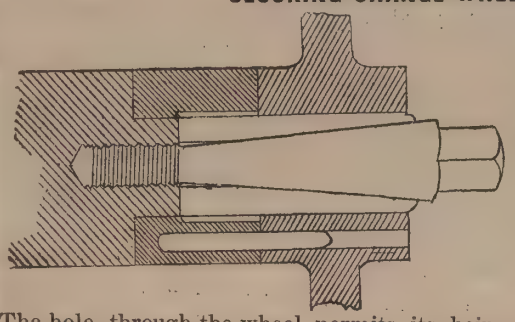
MORE "FIVE DOLLAR" IDEAS.

CONCERNING PAINT MILLS.

Messrs. Editors:—I think it worth $5 to the community to know that you can grind vermilions without heating or discoloring, and more rapidly than in a cone or plate mill, between two rollers of unequal diameters, geared with wheels of the same size. The larger wheel has a faster peripheral speed, hence the action is mulling, not cracking. The contact is on a line only, hence no heating. A knife scrapes off the ground material. It may be used for several colors, as being easily cleaned. The diameters should be three to one. H. F. K.

Buffalo, Oct. 8th, 1877.

SECURING CHANGE-WHEELS TO LATHES.



The plan of expanding seat, (shown in the sketch), for securing change-wheels to lathes, avoids all loose pieces, holds the wheel absolutely rigid, and takes but a turn or two with the tool-post wrench to make the change. The pin in the place of feather, which should extend only half through the wheel, is cheapest and best, as it is farther from the centre, and subject to less strain. The hole through the wheel permits its being used either side to. The end of the screw and stud are split, and expand by screwing in the taper-pin. J. E. S.

Premium for Ideas.

We offer as a premium for the best "$5.00 idea on a one cent postal card," reaching us during the month of November, a year's subscription to The Polytechnic Review. Make the sketches sharp and distinct.

CONFUSION OF MECHANICAL TERMS.

We have already had a communication* relating to the variance in the names of mechanical processes and appliances; and the subject is very well worth referring to again.

It is certain that there is no uniformity, and not always any appropriateness, in the terms. For instance, while the term "S wrench" gives a tolerably fair idea of what is meant, how many know that the monkey wrench was named from the inventor, the late Mr. Thos. Monkey, of Bordentown, N. J.? If the S wrench had been called the Baxter wrench from its inventor, there would have been nothing to distinguish it from the Coes or any other wrench.

What is a shaft in a printing press, is an axle in a car truck, a spindle in a moulding machine, an arbor in a watch or a saw-mill, a mandrel somewhere else, and an axis elsewhere. This is bad enough, to have several names for the same element, but sometimes two or more entirely different pieces have the same name. For instance, here in Pennsylvania we give the name "shaft" not only to an axle, (or axis, or arbor, or spindle, or mandrel,) but to that part of a carriage which, further north, is called a *thill*. Worse yet, names are actually transposed at times. Thus, what we call a jack-plane, which does not mean anything, the English call more appropriately, a *fore-plane*, because it does the roughing out work *before* the smoothing. Our fore-plane is not the before-plane. It is sometimes annoying to have the same thing called by different names by two trades in the same locality, where the use and purpose is exactly alike. Sometime ago, in writing a description of a pipe coupling, a certain tapered and shouldered piece, used in expanding a ring, was called by us a *drift-pin*. The MS. went to New York and came back with the word "tam-pin" substituted. We sent the pin to a plumber and pipe fitter, with a request to name it; the answer came back, "tam-pin." We kept the piece upon our desk and had it named by various callers, most of them called it a *drift-pin*—the name used in boiler-making and machine-shop practice. Some of our readers may have other names for it.

Some months ago, we had a great deal of amusement inquiring what a "shim" was, and noted† the replies received from the leading mechanics and machinists in Philadelphia and New York. It was a New England expression for a thin piece of metal or other material, used to pack out or keep apart two surfaces, as used in aligning shafting, hangers, &c.

A correspondent in the *Journal of the Franklin Institute*, sometime ago, queried anxiously concerning the origin of the term "wane-edged," as applied to a piece of timber imperfect or wanting on the edge or corner. It would, however, seem that the etymology of this term was not so obscure—the terms "wanting" and "waning" are preserved to us in Scripture and in poesy; and the kindred of "want" and "wane" is manifest.

But how is the average mechanic (or other person) to know that *cam* is the Welsh for "crooked" or "bent?" Few mechanics, in fact few of any occupation, are well up in etymology.

Luckily this last term is nearly universal in English, although the device is called a wiper, heart-wheel, &c., according to its form. The only trouble comes in when an English-speaking mechanic comes across the German words, *daumen* and *anlauf*, the French *butoir*, or the Italian *palmola* or *dentata*.

Etymology might help him out. But how about those cases where even the etymologist would be baffled? What would an etymologist get out of the word "arbor," the Latin for *tree?* All the etymology in the world would not help a German (or any one else) to find out what a monkey-wrench was. There is not even a glossary of workshop terms in any of the leading languages, much less such a polyglot dictionary as would have been so useful at any of our International Industrial Exhibitions.

What we want is appropriateness and uniformity of workshop terms in each language, and a glossary to be used when in doubt.

Rendering the nomenclature uniform in various languages, would truly make it more confusing to all except those from whose language the terms were adopted. G.

*By J. R., Vol. III, page 58 Date, Feb 24, 1877.
†Vol. III, page 116. Date, March 24, 1877.

[Copyrighted.]

SLIDE VALVE GEARS.

BY HUGO BILGRAM, M. E.

PART III.

INDEPENDENT CUT-OFF GEARS.—§ I.

As perfect as the link-motions may appear as regards the variableness of the cutting off, they notwithstanding possess one undesirable feature. They admit of a regulation of the *admission* of steam, but the *exhaust* is dependant on this regulation, and the objection existing against the use of an early cut-off by the common slide valve, holds good for link-motions. For this reason the "independent cut-off valves" have been devised, which are combinations of two or more valves that admit a variation of the cut-off independently of the exhaust. They are very extensively in use on larger stationary and marine engines, but their applications to locomotives did not meet with much favor on account of their complication.

The functions of admission and of exhaust may be entirely separated, *i. e.*, distinct valves may be used for each of those functions; or a main-valve similar to that of the common slide can be made to control both admission and exhaust, leaving to the second or cut-off valve the sole duty of closing the admission of the steam at an earlier period than the main-valve does. The first class includes the disengagement valve gears, which are generally of a more complicated construction, although their theory is very simple. Gears of the second class are less complicated, but their study offers more difficulty, and this class will be considered in the following:

Such valves may be arranged in two different ways. In

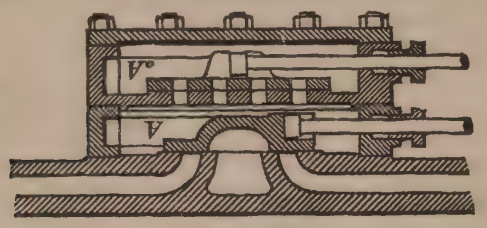


Fig. 57.

Fig. 57 a partition divides the interior of the valve-chest in two chambers, in each of which one of the valves are placed, which are moved independently of each other. Both valves are shown in their neutral position. The cut-off valve $V°$, is a plate with rectangular perforations or ports coinciding with equal perforations of the partition. A movement of this valve exceeding the width of these ports will interrupt the admission of steam. One single opening in both the valve and the partition valve would answer, but it is preferred to make a number of smaller ports, in order to reduce the travel without reducing the total port opening, for the sake of reducing the loss of power from friction. Such valves are known by the name of "Gridiron valves."

The main valve V is of the same construction as the common slide valve.

The second way is shown in Fig. 58. The cut-off valve $V°$

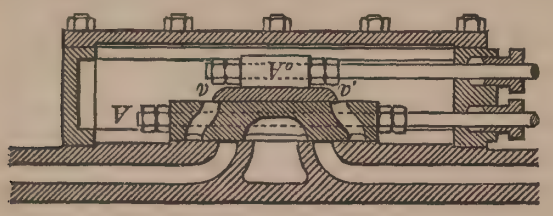


Fig. 58.

is placed directly over the main-valve V, and to make it effective, the main valve is extended on both sides to form two steam passages, v and v'. These valves are again shown in their neutral position, to show their relative proportion and their laps; they will, however, rarely attain this position simultaneously when in action.

These valves are usually operated by two separate eccentrics. The action of the main valve V is identical with that of the common slide valve; the cut-off valve $V°$, in closing the passages of the main valve, will interrupt the admission of steam earlier than the main valve will. The operation of this cut-off valve requires a special study; for the present case differs from our former investigations in that this valve is not sliding over a fixed seat, the seat being formed by the main valve, which has a movement of itself. What we have to consider is not the actual movement of the cut-off valves, but *its movement in relation to that of the main valve.*

Turning our attention to the position of the eccentrics I and $I°$ (the latter being the cut-off eccentric) in relation to the crank $O\,K$ (Fig. 59), we note the movement of the main valve to be represented by the distance $O\,t$, where t is the horizontal projection of the eccentric I. The *absolute* movement of the cut-off valve is the distance of the projection $t°$ of the cut-off eccentric $I°$ from the centre O, but this distance is of little value for our investigation. The *relative* movement of the cut-off valve, *i. e.*, the distance of the centre-line of the cut-off valve from the centre-line of its seat the main valve, is the distance $t\,t°$, and this distance is the horizontal projection of the line $I\,I°$.

If we now draw the line $O\,J°$ parallel to $I\,I°$, or in other words, if we shift the line $I\,I°$ parallel with itself along the centre line $O\,I$ of the main eccentric to $O\,J°$, it is evident that the projection $O\,t'$ of the line $O\,J°$ must be equal to the projection $t\,t°$ of the line $I\,I°$, which is equal to the relative movement of the cut-off valve; and if we can prove this relation of the line $O\,J°$ to remain unimpaired by a rotation of the crank, we may regard the point $J°$, the ideal eccentric of this movement.

Let us therefore view the case after the crank is rotated through the angle a (Fig. 60). The relative movement of the cut-off valve (which, by the way, is negative in Fig. 60), is again represented by the distance $t\,t°$, which is likewise equal to the distance $O\,t'$, proving the above supposition.

We can therefore compare the relative movement of the cut-off valve with the movement of the same valve over a fixed seat when operated by the eccentric $J°$. This conclusion

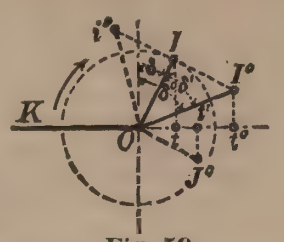


Fig. 59.

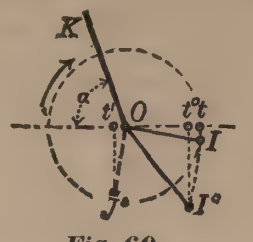


Fig. 60.

renders possible the application of the valve diagram, as will be shown hereafter.

THE GONZENBACH CUT-OFF GEAR

The valves of this gear are like those represented in Fig. 57, each of them being moved by a separate eccentric.

To investigate the action of the cut-off valve, we must consider that the ports are fully opened when the valve is in its neutral position, and that the port opening is reduced by a movement of the cut-off valve, no matter to which side the movement takes place. For the latter reason it is indifferent whether the cut-off eccentric $I°$ is secured to the shaft in the position shown in the diagram, Fig. 61, or diametrically oppo-

Fig. 61.

site. The four ported valve (Fig. 57), having the same effect as a valve with only one port of four times the width of the ports shown, and four times its travel, we should consider the ideal eccentric of the movement of the cut-off valve to be in $J°$, the distance $O\,J°$ being equal to four times the throw, $O\,I°$, of the eccentric $I°$. The lap-centres, Q and $Q°$, of the valve diagram, Fig.

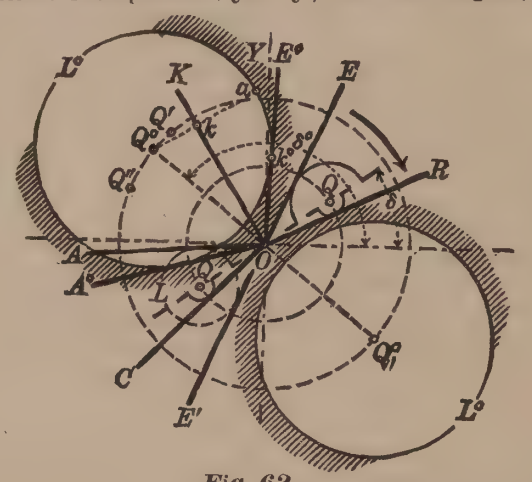


Fig. 62.

62, can be constructed in the usual manner by rotating the diagram Fig. 61, through 90° and inverting it, *i. e.*, by carrying the angles of advance, δ and $\delta°$ from the horizontal centre line in a direction opposing the rotation of the crank-shaft. The cut-off valve is in fact a double valve (closing the ports when moving either way), with a negative lap, on both sides, equal to the collective width of the ports, and the lap circles $L°$ can accordingly be drawn. The opening of the ports for the crank angle $O\,K$, for which the collective movement of the valve, *i. e.*, the real movement of the valve multiplied by the number of ports, is represented by the like $Q°\,k$, is found by deducting this movement from the collective width of the ports (collective negative lap) $Q°\,a$, hence the distance $k\,a$, shows the sought total opening of the ports. We can therefore conclude that the cut-off valve will admit steam as long as the crank-line passes through the inside of the lap-circle $L°$.

The diagram (Fig. 62) can now be completed by adding that of the main valve, when the operation of the double valve will be seen very plainly. The admission of steam begins at OA, when the main valve opens the port of the cylinder, the cut-off valve having been opened before, at $OA°$. At $OE°$ the cut-off valve closes its ports very sharply, as attested by the comparative length of the line $Ok°$ exceeding even the length OQ or the maximum speed of the main valve, and expansion commences. The exhaust, indicated by the diagram of the main valve, is, of course, not affected by the cut-off valve.

The most effective way of varying the rate of cut-off is a change of the angular advance of the cut-off eccentric, but the diagram will show that this change is limited.

A reduction of the angle $\delta°$ (Fig. 62) will dely the cutting-off, the point $Q°$ being shifted towards Q'. This change will, however, also involve a delay of the opening of the cut-off valve at $OA°$, which should never be carried beyond the line OA where the main valve opens the port.

A hastening of the cut-off can be accomplished by increasing the angular advance $\delta°$ (advancing the cut-off eccentric on the crank-shaft) when the point $Q°$ of the valve diagram will be shifted towards Q'', and the cutting-off will take place earlier than before. This measure must, however, not be carried too far, as the opening of the cut-off valve, at $OA°$, may be hastened so much as to take place before the main valve has closed, at OE', the admission at the preceding stroke, and steam will be admitted to the cylinder twice at every stroke. This would evidently be very wasteful, as the steam admitted after the second opening would not return an adequate amount of work.

The range of variation, admissable without trespassing these limits will depend on the outside lap of the main valve; for the lap circle L defines these limits, and hence, by giving the main valve ample lap, the admissable range of cut-off can be made to cover nearly all grades desirable in practice.

The advantages of this valve gear consist in the sharpness of the cutting-off and in the simplicity of its construction; but the inconvenience of having to stop the engine for changing the cut-off impedes its general adoption. The utilization of the steam is somewhat injured by the circumstance that the lower chamber of the valve-chest remains in communication with the cylinder after the cutting off, thus increasing, as it were, the space of the clearance.

Problem XI.—Construct a valve gear of the above description, having a maximum follow of steam of two-thirds of the stroke and a greatest port opening of $1\frac{1}{4}''$, when adjusted to $\frac{1}{16}''$ of lead. The number of the cut-off ports shall be three, and each is to be $1\frac{1}{8}''$ wide. Draw the diagram, determine the highest attainable degree of expansion, and find the amount of cushioning if the inside lap is equal to zero.

We give the main valve as much lap as possible by making it to cut off as early as the required conditions permit, which is at $\frac{2}{3}$ of the stroke. The diagram (Fig. 63) of the main valve

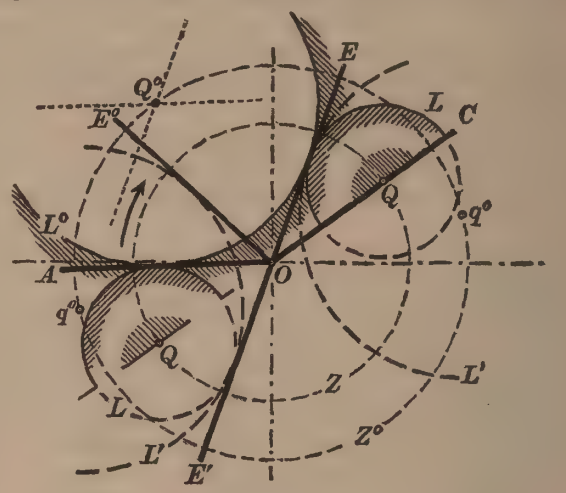


Fig. 63.

can thus be drawn, and will furnish the following dimensions: Lap$=1\frac{5}{16}''$, and travel$=5\frac{3}{4}''$. The compression is found to last for $\frac{1}{10}$ of the stroke. The cut-off valve should now admit steam between the crank-lines OA and OE; and since we know the radius of the lap circle $L°$ of the cut-off valve to be $=3\frac{3}{8}''$, we can find its centre by two lines drawn parallel to OA and OE at a distance each of $3\frac{3}{8}''$, and can draw the same tangential to $O\,A$ and $O\,E$. One-third of the distance $O\,Q°$ is the required throw of the cut-off eccentric, which is found to be$=1\frac{3}{8}''$ An advance of the cut-off eccentric for the purpose of hastening the cut-off, can only be carried so far till the lap circle L' becomes tangential to the cut-off line $O\,E'$ of the main valve, as indicated. $O\,E°$ will accordingly be the crank angle for the earliest cut-off, and is found to correspond with $\frac{1}{8}$ of the stroke. The regularities of the eccentric rods might, however, admit a slight opening of the cut-off valve before the main valve closes, at $O\,E'$, and therefore should the eccentric never be advanced quite as far.

This cut-off gear is frequently used on marine engines in connection with link motions moving the main valve. The change of expansion is, however, accomplished by a change of the *travel* of the cut-off valve by means of a separate link worked by the cut off eccentric, on a fixed fulcrum. An investigation will show that by this plan the range of expansion is very limined indeed, the centre $Q°$ of the valve diagram (Fig. 62) moving in or out on the line $OQ°$ or on a curve* not much deviating from this line. By combining this cut-off valve diagram with the diagram of the main valve for *backward* rotation, it will appear this cut-off valve is unserviceable altogether, admitting steam twice at each stroke and withholding it at the intervening period. The cut-off valve must therefore be thrown out of gear when the engine is backing, by shifting the cut-off link-block close up to the fulcrum of the cut-off link, to keep the valve open entirely.

The unequality of the cut-off, owing to the oscillation of the connecting rod, can be rectified by giving the cut-off valve unequal lap, *i. e.*, by lengthing or shortening the valve stem, according as the cut-off eccentric is located at $I°$ (Fig. 61) or diametrically opposite. This correction can however be made to suit only one angle of the connecting rod, and it is well to choose the angle corresponding to $\frac{1}{4}$ of the stroke of the piston, when the same correction will also cover the cutting off at $\frac{3}{4}$ of the stroke, the angle of the connecting rod being the same.

In practice, the cut-off valve can easily be adjusted on the work. But if it is desired to know the amount of adjustment before hand, it can be found by the diagram as indicated in Fig. 64.

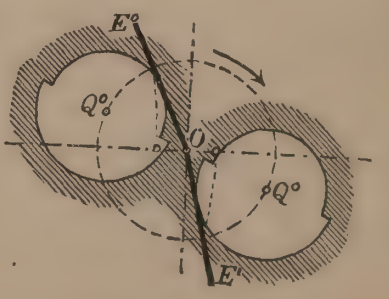


Fig. 64.

*The character of this curve will be more closely investigated in a subsequent chapter, where its form is of more consequence.

(*To be continued.*)

PROGRESS IN SCIENCE AND THE ARTS.

☞ This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Clearing up an Astronomical Muddle.—There is a curious and fitting sequel to the inconsequent muddle which M. Faye brewed, mixing an asteroid with the satellites of Mars. It will be conducive of clearness to recite the facts from the beginning. Professor Watson, of Ann Arbor, saw an asteroid, but did not at the time identify is as such; a few nights afterward he saw it again, and claimed it as his discovery; but in the meanwhile M. Borelly, of Marseilles, had found the object, recognized it as a planet, and thus acquired the right of discovery for himself. Also, it happened about this time, that M. Borelly succeeded in seeing with his telescope, one or both of the satellites of Mars, which Professor Asaph Hall, of Washington, had discovered. In announcing all the foregoing to the French Academy of Sciences, M. Faye got matters so strangely mixed in his own mind as to state that M. Borelly had discovered one or both of the satellites of Mars before Professor Watson. That tangle has been all straighted out, and now comes the denouement, which, it is to be hoped, is final. The asteroid in question, which had been labelled 174 and credited to M. Borelly, must be crossed off the list altogether. It turns out to be an old one, Dr. Knorre having investigated its orbit, and found it identical with asteroid No. 141, discovered January 13, 1875.—*N. Y. Tribune.*

Iron and Glue in Street Dust.—In this country we have assays of street dust yielding gold in some towns, but glue and iron we have not searched for. We read in exchanges that Signor Parnetti has been engaged in analyzing the dust and *debris* of the streets of Florence and Paris. His investigation of the *debris* of the horse paths proves that the dust contains 35 per cent. of iron, given by the shoes of the horses to the stones. In the dust from the causeways this eminent chemist finds from 30 per cent. to 40 per cent. of good glue. Signor Parnetti selected and treated separately the dust from the causeways of the Boulevard des Italian over a period of two months, which uniformly gave 30 per cent. of good transparent glue, it is said quite equal to Belfast. This eminent chemist is now engaged in the analysis of the dust and *debris* deposited by the shoe abrasions in Lombard street, Cornhill, Cheapside, and other thoroughfares of London, and has it in contemplation to place his discoveries at the disposal of a limited company, with the view of establishing blast furnaces on the banks of the Thames to recover the iron thus lost, and a large glue works, which, it is thought will produce more glue from the wasted material than will supply all London for every purpose.

Staining of Sheet Zinc.—Among recent German inventions is a simple process, depending on the use of acetate of lead, by which every kind of color is applicable to sheets of zinc. By mixing black lead for instance, with the salt, a very agreeable light brown hue is obtained. It is by this process the cupola of the synagogue at Nuremberg has been painted. A sufficient length of time has already elapsed, it is said, to show that the atmosphere has no influence on the zinc sheeting of the roof, thus showing the practical value of the process in such cases. By the addition of other coloring matters, light or dark shades of yellow or gray may be produced.

The Manufacture of Artificial Black Walnut, by which ordinary wood has imparted to it the appearance of the most beautiful specimens of walnut, adapted to the very finest cabinet work. The wood, first thorougly dried and warmed, is coated once or twice with a liquid composed of one part by weight, of extract of walnut peel, dissolved in six parts of soft water by heating it to boiling, and stirring. The wood thus treated, is when half dry, brushed with a solution of one part by weight of bichromate of potash in five parts of boiling water, and, after drying thoroughly, is rubbed and polished. The color is thus said to be fixed in the wood to a depth of one or two lines, and, in the case of red beech or alder, for instance, the walnut appearance is most perfect.—*Iron Age.*

The Quadruple System of Telegraphy, the last importation from America, is now being tried on a wire between Liverpool and London. The experiments bid fair to be successful.—*English Mechanic*, xxvi, 89.

Prehistoric Monsters.—Prof. Cope has recently described, under the name of *Camara-saurus supremus*, a saurian which appears to have been larger than any land animal yet known. The New York *Independent* says: It is represented by a larger part of the skeleton, which was dug from a bed of the Dakota epoch of the Cretaceous period, at a locality near to Canyon City, Colorado. It was discovered by Mr. O. W. Lucas, Superintendent of the public schools of that county. Its thigh bone measures more than six feet in length, and the expanse of some of the vertebra is three and one-half feet. The vertebras are of a very light construction, their bodies being mere shells surmounting large hollow chambers. A neck vertebra is 20 inches long, giving at least 10 feet for the entire neck. The body must have been 10 or 12 feet in length. The specimen is very complete, Mr. Lucas having taken great pains to secure its preservation. A somewhat similar specimen was recently sent to the museum of Yale college, but this one is larger and in better preservation. Prof. Cope has also recently called attention to a number of teeth of a huge land saurian, which evidently inhabited Pennsylvania at an early geological period. The specimens were found by Charles M. Wheatley, of Phœnixville, Pa., in one of the copper mines, in the red sandstone and shale which traverses the State from northeast to southwest, in the eastern section. This reptile, which is new to science, was probably 30 feet in length, with a bulky body, supported by heavy limbs. The teeth are double-edged and firmly serrate and of the kind characteristic of the carnivorous saurians. The reptile was, doubtless, one of the most formidable that ever inhabited the State, and, in point of time, the earliest. It has received the appropriate jaw-breaking name of *Palœoctonus Appalachianus.* What appeared to be a large bone of a similar animal was discovered not long ago in a sand-stone quarry in Newport, N. J., but has not yet been described.

An Efficient Preservative against Lead Poisoning would, we suppose, be welcomed by pottery glazers and workers in the poisonous preparations of lead; but the preservative must be something that can be taken or applied with the minimum of trouble. It is stated that washing the hands thoroughly with petroleum three times a day has been found to prevent all symptoms of lead-poisoning amongst some workers who have given it a fair trial, and who are so satisfied that that they recommend it for trial by those liable to injury from the salts of copper or mercury.—*English Mechanic*, xxvi, 88.

Waterproof Leather.—For the preparation of impermeable leather, a coating composed of a litre of linseed oil, 125 grains of tallow, 46 grains of wax, and 32 grains of resin, melted together, is applied while yet warm to the surface of the leather. The fishermen of England have for a long time employed a coating of linseed oil and tallow for rendering their boots waterproof. The addition of resin and wax improves the efficacy of the coating.—*Revue Industrielle*, viii, 388.

Separation of Nickel and Cobalt.—The separation of nickel and cobalt has hitherto been a somewhat difficult operation, but by the new method, which was made known a short time ago, this is effected easily and rapidly. The following method of detecting and isolating minute quantities of nickel in commercial chloride of cobalt, supposed to be pure, will give an idea of its practical nature:—A few grains of that salt are dissolved in water, and the whole of the cobalt precipitated, with the nickel, by xanthate of potash employed in slight excess, and previously dissolved in a little distilled water. A few drops of ammonia are then added, just sufficient to render the liquid slightly alkaline, and the dark green xanthate of cobalt is collected on a filter. The whole of the nickel is in the filtrate, and the whole of the cobalt in the filter. The nickel in the filtrate is precipitated by a few drops of sulphide of ammonium.

Artificial Fuel.—Reliable estimates place the production of artificial fuel in Europe at the enormous total of 4,000,000 of tons. Over 400,000 tons of pitch are sold for this purpose yearly, of which 50,000 tons alone are from the immense establishment of Burt, Bolton & Haywood, of London, the largest coal-tar distillers in the world.—*Saward's*, xiv, 135.

Character of Xanthates.—Besides the yellow precipitate which the soluble xanthates give with salts of copper, all the insoluble xanthates, on dissolving in nitric acid, give rise to nitrous ether, which is readily recognized by its odor.—*Chemical News*, xxxvi, 150.

Influence of Pressure upon the Phenomena of Combustion.—M. V. Wartha.—The author has burnt stearine candles in the air at an ordinary pressure and at a pressure of 1·95 atmospheres in a large iron chest, determining in each case the quantity of matter burnt per hour. Those burning at the common pressure had a flame 4·5 to 6 centimetres in height, and consumed hourly from 9·34 to 10·70 grms. of stearic acid. At the increased pressure the flame was very sooty, of a yellowish-red, and from 9 to 12 centimetres in height, but the quantity of stearic acid consumed was only 7·99 to 9·11 grms. He burnt also candles at very low pressures, as, *e. g.*, 9 centimetres of mercury. The flame was much increased, lost its brightness, and took a greenish-blue color. Three portions could be plainly distinguished; the central part of a greenish-blue, quite detached from the wick, and having the form of a cap; this part is enveloped in a violet mantle, and and this again in a second violet mantle so pale as to be scarcely visible.—*Journal fur Praktische Chemie*, xiv, 84.

Incombustible Silicate Board.—The process for manufacturing silicated paper board, principally designed for roofing, simply consists in impregnating sheets of the paper board alternately in solution of silicate of soda or of potash, and in another of chloruret of barium or of another salt. The chloruret of barium can be replaced by other soluble salts which are cheaper provided that they give insoluble silicates, such as the salts of lime, aluminium, magnesia, iron, lead, zinc, &c. The entire mass of the board is thus impregnated with a silicate of baryta or other equally insoluble, and at the same time with a certain quality of silex. These substances not only enter, but form in the very substance of the sheet, an insoluble varnish which protects it against the weather, increases its resisting power and renders it incombustible. Instead of making use of prepared board the matters can be incorporated in the pulp. This proceeding is equally applicable to paper, wood, stuffs, &c. It will take various colors, is extremely light and economic.—*Bulletin du Musee de l' Industrie de Begique.*

Climate Changes in Europe.—A Swedish paper just received publishes an interesting article under the heading, "Why is the Climate of Europe growing Colder?" The article states that in the Bay of Komenok, near Koma, in Greenland, fossil and very characteristic remains of palm and other trees have been discovered lately, which tend to show that in these parts formerly a rich vegetation must have existed. But the ice period of geologists arrived, and, as a consequence of the decreasing temperature, this fine vegetation was covered with ice and snow. This sinking in the temperature, which moved in a southerly direction, as can be proved by geological data, *i. e.*, the discovery of fossil plants of certain species, seems to be going on in our days also. During the last few years the ice has increased far towards the south; thus between Greenland and the Arctic Sea colossal masses of ice have accumulated. On European coasts navigators now frequently find ice in latitudes where it never existed before during the summer months, and the cold reigning upon the Scandinavian peninsula this summer results from the masses of ice which are floating in the region where the Gulf Stream bends towards our coasts. This is a repetition of the observations made in the cold summer of 1865. The unaccustomed vicinity of these masses of ice has rendered the climate of Iceland so cold that corn no longer ripens there, and the Icelanders, in fear of a coming famine and icy climate, begin to found a new home in North America.—*Nature*, xvi, 467.

ENGINEERING—CIVIL AND MECHANICAL, &c.

The Poughkeepsie Bridge.—A meeting of the directors of the Poughkeepsie Bridge Company was held on Tuesday of last week at Poughkeepsie. Before the business meeting the directors went in a tug to investigate the work done. The westerly pier was found to be fixed on the solid gravel bed ninety-seven feet below the surface of the water. The granite is beginning to arrive, and the work will be begun shortly. The second caisson is sunk seventy-five feet below the surface. The depth of the mud is greater than with the first pier, so that a foundation will be secured 112 feet below the surface. Both these caissons are immense timber structures, and will be filled with solid concrete to a point twenty-five feet below the surface, where the granite pier will begin. All the piers for this bridge will be sunk to a depth greater than that of any bridge piers in the world. There are to be four piers in all, and two will be completed to a point twenty feet above the water before the river freezes. The height of the piers above the water is to be 130 feet, and the depth of the truss 60 feet, so that the railroad track will be 190 feet above the water line. The bridge, which is being built by the American Bridge Company of Chicago, will be the finest structure of the kind in the world.—*Chicago Railway Review*, xv, 108.

Burning the City's Refuse.—The new system of disposing of street garbage by cremation has been in working order for three weeks, under a contract entered into between the Police Commissioners and the Refuse Company, for the destruction of the garbage gathered in the Seventh Ward. The operation was publicly exhibited recently. Among those present were Police Commissioners Smith, Wheeler and Erhart, ex-Mayor Wickham, Alderman Purroy, and Colonel Ethan Allen. Twenty-five loads of garbage were burned. The product, from five to twenty per cent. of the matter burned, is stated to suitable for filling, roofing, roadways or ballast. The furnace employed is the patentee's model and was only run at a low pressure yesterday. The furnace to be used, in case the city enter into a contract for the cremation of all the garbage collected, will be thirteen feet in diameter, sixteen feet high, with a capacity of burning 1,000 loads of garbage and ashes in twenty-four hours. There will be six furnaces in different parts of the city, convenient for the garbage carts.

During the three weeks the Seventh Ward contract has been in force, 300 loads of garbage have been consumed, and the opinion of those who live in the vicinity of the furnace, at 390 Front street, the ruins of the Ockershausen sugar refinery, is that no unpleasant odor is emitted. The garbage, just as dumped, is shoveled into a furnace with large fires and a heavy blast beneath. Seventy-two loads a day are thus disposed of, and the entire work is performed by four laborers and an engineer. The gases evolved are passed into the boilers, and all unpleasant odors are consumed. Colonel Foote states that he has been informed by the Police Commissioners that it costs the city $500 a day to tow out and dump 3,500 loads of garbage into the sea, and Mr. Foote believes, if the city undertake the cremation plan, the product will sell for enough to pay for the expense of the furnace. He states that he has been offered 20 cents a load for all the product he can deliver. The Manhattan Refuse Company at presents consist of Henry R. Foote, constructing engineer and patentee, Colonel F. E. Howe, George N. Hay, Jr., and Major Cragin.—*N. Y. Tribune.*

A Costly Railroad will be the extension of the Metropolitan District line in London—a section one mile and sixteen rods long, known as the "inner circle completion," as it will connect the Metropolitan and Metropolitan District roads (both underground lines) at their eastern ends, and make it possible to run trains entirely around the ellipse formed by the two roads, which at present are connected only at their western ends. This link is estimated to cost £2,100,000, or at the rate of about $10,000,000 per mile. The city will, however, allow $2,500,000 for a new street which has to be constructed in connection with the work, which is to be done by Aug. 7, 1879. Costly as this work is, however, we have something quite comparable to it in expense in this country in the great St. Louis bridge, which, however, has but the merest fraction of the traffic which supports the London underground roads. This single mile of road will cost more than the entire system of elevated roads proposed for New York. —*Railroad Gazette*, ix, 447.

Elevated Railway in Chicago.—It is stated that a company will soon apply for a charter under the general law, to be known as the Chicago Elevated Railway and Rapid Transit company. The idea is to run a line south from Jackson street by way of the South Parks to Hyde Park. If the company succeeds in organizing (which it probably will, as large capitalists are in the scheme), its capital will be $1,500,000. After a charter is obtained the matter will come before the Council in a petition for the right of-way through the city. So far, it is probably only an "idea."—*Chicago Railway Review*, xv, 111.

Progress of the St. Gothard Tunnel.—The advancement made in the St. Gothard Tunnel during the week preceding the last, was 16 6 m. at the Goeschenen and 21.3 m. at the Airolo end, a progress of 5.4 m. per day. On account of the brittleness of the rock, three days' work was lost at the Goeschenen and two days at the Airolo end.—*Moniteur Ind. Belge*, iv, 402.

An Oil for Belting is recommended by our contemporary *Techn. Blatter*, which consists of 9 parts of linseed oil and 4 parts of litharge ground in water, these boiled to a plastic consistency, and then liquified by an addition of turpentine, furnishes an oil which possesses (so we are informed) many admirable qualities.

—Porter, Bell & Co., of Pittsburgh, have recently shipped to the Colorado Central one 6-wheeled narrow gauge engine and are building another engine for the same company. They have also shipped one narrow gauge locomotive to the C. W. & C. R., of Ohio; and one to Texas.

Competitive Brake Trials in Germany.—The official report of the result of the competitive trials of continuous brakes on German railway lines, which were made on the first four days of August, at Guntershausen, is not conclusive, as the commission apparently desires to continue its investigations. It is acting on the impression that continuous brakes have not been perfected, and that further improvements should be made before they are introduced on German lines. But it is easy to carry this theory to dangerous limits. Where would railways or the locomotive be to-day, if companies had waited for the approximate perfection of any essential feature of the modern transportation system? It is certainly desirable that any important new device which has such a manifest tendency to promote safety and avoid accidents as the superior continuous brakes of the present day should be attached to the passenger trains of every steam railway, the postponement of action on such a vital subject, on the plea that improvements may be made, is unwise and unjust.—*R. World.* iii. 938.

Record of New Railroad Construction.—The *Railroad Gazette* for October 5th has information of the laying of track on new railroads as follows:

Raleigh & Augusta Air Line.—Extended southwest 12 miles, to Hamlet, N. C.

New Orleans, Jackson & Northern.—An extension has been built from the depot in New Orleans to the levee, about 2 miles.

Cincinnati & Portsmouth.—The first track is laid from Cincinnati, O., east to Mount Carmel, 11 miles. It is of 3 ft. gauge.

Toledo & Delphos.—Extended from Jennings, O., north by east to Dupont, 10 miles. It is of 3 ft. gauge.

Union Railway, Transfer & Stock Yards.—This company's road, generally called the *Indianapolis Belt*, has track laid from Brightwood around the east, south and west sides of Indianapolis to the Bloomington crossing, 10 miles.

Chicago, Burlington & Quincy.—The *Keithsburg Branch* is extended from Keithsburg, Ill., north to New Boston, 3 miles.

Kansas Central.—Extended from Holton, Kan., westward to Soldier Creek, 12 miles. It is of 3 ft. gauge.

Southern Pacific.—Extended across the Colorado River to Fort Yuma, 1 mile.

This is a total of 61 miles of new railroad, making 1,396 miles completed in the United States in 1877, against 1,677 miles reported for the corresponding period in 1876, 804 in 1875, 1,101 in 1874, 2,778 in 1873, and 4,970 in 1872.

Gas Machines.—(The new Otto and Langen Engine.) At a recent meet of Gas and Hydraulic Engineers, held at Leipsic, Engineer Wacker-Deutz introduced a discussion of the new Otto and Langen engine, in connection with the subject of gas engines in general. The many faults of the Lenoir and old form of the Langen engine were pointed out, and the fact noted that but comparatively few of the former were in use. Some 45,000 of the Langen engines are in action. The vertical or old form of these engines act upon the principle of having a free piston driven to the top of the cylinder, and then returned by the pressure of the atmosphere. The new machine is very similar in action to the common horizontal steam engine, and is very simple in construction. The action of the expansion or explosion of the gas in these engines differs from that of the former by being compressed before being ignited. The composition of the explosive gas is 11 parts of atmospheric air to 1 part of illuminating gas. Unlike the former machines a part of the gas is left in the cylinder, and thereby tends to retard the rapidity of the combustion. The noise produced by and so objectionable in the old engines, is entirely overcome in the new form. The suction of the gas from the conduit pipes is often so great that in narrow pipes a noticeable disturbance of neighboring flames is produced. This can, however, be easily obviated by the use of one or two rubber bags inposed between the supply pipe and the machine, Herr. Wacker has experimented in the direction of driving the engine by means of petroleum and other oil gases. The principal difficulty consisted in the incomplete combustion of these vapors, and the consequent choking of the burner and the slide-valve passages of the soot formed, The openings of the valve must of necessity be made smaller, in order to insure complete combustion.

Of the 22 machines of Otto & Langen which are now in operation in Carlsruke, varying from 1 to 4 H. P., and which work with a pressure of 17 m. m. from the gas main, but one (working from a 1½ inch pipe) produced a disturbance in neighboring gas flames, and this was readily overcome by the use of two rubber bags. The use of wet metres is not recommended where these engines are used. The gas consumption of these machines is about ¾ klm. per horse power, while that of oil gas is about 0.38 klm.—*D. Ind. Ztz.*, 1877, 374.

—It has been for some time known that the surface of the Everglades is elevated between four and five feet above the waters of the ocean, and the scheme of draining this immense territory has been advanced. There is now some prospect of the realization of the project, as parties in New York representing abundant capital, have taken hold of the matter, and an engineer has been employed for some time making investigations. This is a subject that will well repay examination, for here are 5,280 square miles of the richest land in the world, capable of raising $600 worth of sugar per acre, without any fertilizers. This land, once drained, would far exceed in value the *polders* of Holland, owing to its semi-tropical position and its adaptability for the raising of bananas, sweet potatoes and all tropical fruits. The report of the engineer making the preliminary survey is looked forward to with lively interest by all Floridians and others who are aware of the capabilities of this region.

The Devil's Elbow, a narrow and dangerous channel bordered by coral reefs and oyster banks, in the Mosquito Lagoon, Florida, which has long been an almost unsurmountable obstacle to the navigation of the Haul Over Canal and a connection between the Lagoon and Indian river, has been entirely removed by private enterprise. A steamboat company running steamers from New Smyrna to the Haul Over Canal have employed dredges, and at a large expense succeeded in rendering the navigation free and safe without any help from the State or National Government. A tramway is to be laid across the narrow isthmus, about 2,000 feet only, at the Haul Over, and freight and passengers transferred to a line of steamers on the Indian river. A new line from Fernandina to New Smyrna has commenced running.—*J. Francis Le Baron, in Eng. News*, iv, 286.

MINING, METALLURGY AND MINERALOGY.

Gallium.—The new metal, gallium, discovered two years ago by M. Lecoq de Boisbaudran, is so slightly diffused that the discoverer had to employ half a ton of zinc from the Pierrefitte mine to get 12 grains of metallic gallium. It resembles pewter in color, is not so soft as lead, but can be bent and cut. When heated to redness, it assumes a slight tarnish, without being reduced to an oxide. It is very fusible, melting with the heat of the hand, forming a white globule, and would form a mirror, like mercury, if pressed between two glass plates. Though melting at a temperature af 86° F., it does not solidify again until considerably below that temperature. It is one of the lighter metals, having a specific gravity of 4.7. Some years ago, Mendejeff, of St. Petersburg, made a study of the atomic weight of the elements, and arranged them in such groups that he thought he could predict the future discovery of elements. To one of these, situated between aluminium and idium, he assigned an atomic weight of 68; but whether gallium corresponds to the hypothetical element in this respect does not seem to be well determined.

Purifying Iron with Chlorine.—William Baker, of Sheffield, England, has invented a process of eliminating phosphorus from molten cast-iron, which consists in the employment of chlorine, which, by being injected into or by being brought into contact with the molten cast-iron, effects the separation in part, or practically entirely, of the phosphorus from the impure cast-iron. In carrying out this invention, he injects or passes into or brings into contact with the fluid molten cast-iron, chlorine in a gaseous form, and he prefers to submit the molten cast-iron to the action of chlorine before it has been subjected to the action of the air, as, for example, in the Bessemer process or in the ordinary puddling process, or to other decarburizing porcesses. Although he has mentioned the employment of chlorine-gas, chlorine, in conjunction with other gases, may be employed; but he prefers to employ chlorine.

A Scientific Survey of Maryland is in progress, having special reference to geological and biological features. The work is conducted under the auspices of the Maryland Academy of Sciences, of which Professor Philip R. Uhler is president. Having accompanied some of the Hayden expeditions, Professor Uhler is especially fitted for the conduct of this survey. The Baltimore *American*, in calling attention to the work already done, states as Professor Uhlin's opinion, from the survey of St. Mary's County, that the vacant land there would exceed that of Kansas in fertility, if properly drained and tilled. The land can be bought at $5 per acre, and as an instance showing how sparsely it is occu-

pied, it is stated that only three buildings were found in a radius of twenty miles. In connection with the work of the survey, and by means of funds contributed by the members of the Academy in addition to the sum devoted from its income, collectors have been set at work throughout the State, and representative specimens of its animals, vegetables and minerals have been obtained for a museum. The fauna and flora of Maryland are said to embrace a great majority of all the species this side of the Mississippi.

Bronzes Incrusees is the name given to a Parisian novelty in bronze or copper work, with gold or silver decorations.

The decorations are painted upon the objects of bronze or copper in water colors containing lead white in large quantities. If many objects are to receive the same pattern, they are printed in the manner of porcelain ware. The article is then placed in diluted sulphuric acid, which dissolves the color and etches the metal to the necessary depth. After washing, the article is placed in a silver of gold bath, and the metal deposited on the etched surfaces by means of a battery.

The varnish is now removed and the whole surface ground, so that the metal shall in no place protrude. The whole can then be bronzed without affecting the gold or silver decoration. A fine effect is said to be produced by depositing black bronze (cuprous sulphide) between the gold and silver.—*Papier Ztg.*, ii, 632.

Peruvian Nitre Deposits.---On the Pacific coast of South America, extending from the fourth to the fortieth degree of south latitude, about 2400 miles along the slope of the Andes to the sea, in Bolivia, Peru, and part of Chili, there has been found a line of deposits of sodium nitrate, the "Peruvian nitre." The beds are of variable thickness, covered by from one ten yards' depth of earth and half-formed sandstone. The dry soil of the greater part of this rainless country is pervaded, in some degree, with this deposit. The mummied remains of the old Peruvian people are embalmed with it by the earth in which they are buried; and its crystals glisten on those ghastly relics which were presented in the Peruvian department of the Centennial Exhibition, and those brought to this country by Dr. Steere. It has been estimated that in the Province of Tarapaca, within fifty square leagues, the quantity of the nitre is not less than 63,000,000 tons. The appropriation of this last resource his been taken up rather slowly, but has much increased for ten or twelve years past. Vessels laden with it go to the coasts of manufacturing countries. At Glasgow the works devoted to the production of ordinary saltpetre from the nitre of Peru extend over acres of ground. In 1868, 100,000,000 lbs. were used in Great Britain. As yet it has been applied to the nourishment of crops only to a limited extent. But this seems to be its chief destination, and for this use it lies in the earth, a vast mine of wealth, for the disposal of coming generations. When multiplied population puts the sustaining power of the earth really to the test, this fund of sustenance on the Peruvian coast may come to outweigh in value the gold and silver mines of the Californian coast.—*The Engineer*, xliv, 219.

—Greensand marl, says the Savannah *News*, has been found in Houston county, near Perry, the layer of which is two feet thick, and doubtless extends through the county. This is the first reported in Georgia, and is reported equal, if not superior, to the celebrated New Jersey greensand.

—A fine ledge of lithographic stone has been found of the lands of Bruner & Adams, near Winchester, Ky.

MISCELLANEOUS.

The Immense Stones used in the erection of the pyramids of Egypt were obtained from the quarries in the Arabian hills, and were carried to the river and over a bridge of boats. They were then brought forward by means of a causeway, which is said to have been a fine work, with its polished stones and figures of animals engraved upon them. One hundred thousand men were employed at a time, and these were relieved by the same number at the end of three months. A long time was spent in the leveling of the rock on which the edifice stands, and twenty years for the erection of the pyramid itself. The stones were raised step by step by means of a machine made of short pieces of wood, and, last of all, commencing from the top, the stones were cemented together with a layer of cement not thicker than a piece of paper, the strength of which is proved by the age of these enormous memorials.—*Engineering News*, iv, 270.

The Pennsylvania Salt Company, of Greenpoint, are to employ two new vessels in the work of bringing cryolite from Ivigtok, South Greenland. The vessels are barks, and were recently launched at Quebec. The frames are very solid, and double the size of an ordinary vessel, well fortified for ice, diagonal pointers and five-inch planking. The bows are iron-plated.

American Industrial Progress.—Our locksmiths, says the Philadelphia *North American*, are following up their predecessors, and have forced the Staffordshire rivals to complain as the sawmakers of Birmingham and Sheffield do of the evils of free trade in saws. So far as the saws are concerned, they have compelled English manufacturers to copy American styles or lose their business, and other hardware is rivaling that in excellence and in effect, while saddlery and harness is close in the wake of saws, locks and general hardware. British testimony to and lamentations over this state of affairs is general and continuous, and proves that while locomotives, mills and railway material are going into South America in greater quantity, and cottons continue to flow to Europe and India, and agricultural machinery to Australia, and miscellaneous productions everywhere, the minor industries are following the major, and by their superiority and cheapness establishing that foreign vent for domestic produce we so ardently desire. There is infinite encouragement to will and to do in all this. The progress is made under many unfavorable conditions and against many prophecies of defeat. Still it is made. And if we can eclipse the watchmakers of Switzerland at home, and the Staffordshire locksmiths and Manchester spinners, and gain Turkish and Russian markets for cannon and pistols and guns, while feeding Western Europe with meat and grain and oysters and peaches and apples, we may certainly believe our olden ability is returning and our future welfare is certain.

Greenheart, a variety of timber that grows largely in British Guiana, is a hard, close-grained wood, containing a considerable amount of oil, like teak. Its specific gravity is about equal to that of oak, but is decidedly superior to it in strength, toughness, and durability. These, however, are not its chief advantages, its great value consisting in its complete exemption from the attack of marine worms. It is, therefore, an excellent timber for sluice gates, piles, and all marine engineering works, which would be exposed to their ravages. British Guiana also furnishes morra. This tree grows to a very great size, often attaining a height of from 100 to 150 feet, the lowest branches being 60 feet from the ground. The wood is extremely tough and close grained, which properties make it difficult to split, and render it peculiarly applicable to ship-building purposes. It is also little subject to dry-rot.—*American Builder*, xiii, 227.

Our Trade With Brazil.—The indications that the United States are soon to enjoy an iron trade with Brazil are reported to be unmistakable. The bark Matthew Baird has just cleared from Wilmington, loaded with iron rails, and another vessel is to follow with a similar cargo. A Pennsylvania firm has secured a contract for railroad iron, and will ship some this summer. Wilmington, as reported in the *Bulletin* some time since, has orders for a large number of cars, ten of them being for the Dom Pedro II railway. A few locomotives have also been ordered. Then there is a growing business in street railway material. Years ago, Stephenson sent cars and rails to Brazil, but lost the business at once, owing to English competition. An American who went to Liverpool and set up a street-car establishment there was able to undersell Stephenson in South America. His cheaper labor in England and better ocean transportation enabled him to drive Americans out of the market. Latterly orders have begun to seek the American establishments again. Wheels and other materials are being ordered from this country, and a business in cars and rails is confidently expected. There is no reason why a large business should not be done in this line. Railway material, delivered at the seaboard in the United States, may possibly cost a trifle more than in English ports, but there is something to offset this. Railway iron is a desirable class of ocean freights, because it can be put in the hold of a ship and assist in steadying the vessel—a matter of some consequence when the bulk of the cargo is of flour, as it generally is, and the ship therefore top-heavy and uneasy in the water. The desirability of railway material to the ship as freight and the shorter ocean route from New York to Brazil will enable the stuff to be landed at ports beyond the Equator every dollar as cheaply as European material.—*Com. Bulletin.*

A Manchester Mechanic has invented a horse-shoe composed of cow-hide compressed into a steel mould and then subjected to a chemical preparation. The inventer asserts that it lasts longer than the common shoe, and weighing only one-fourth as much; never splits the hoof, and has no other injurious influence on it; requires no calks, even on asphalt; is so elastic that the horse's step is lighter and surer; and adheres so closely that neither dust nor water can penetrate between the shoe and the hoof.—*Com. Bulletin.*

A Narrow-Gauge Railroad between Ballerica and and Bedford, Massachusetts, is approaching completion. It is eight and a half miles long, and the rails are only two feet apart. The passenger cars will have a row of single seats on each side. The cost of the road is a little less than $6,000 per mile, about one-eighth of the cost of ordinary roads.

—The New Castle *Courant* states that the New Castle Ore Company have broken ground for a narrow-gauge road from that city to the great ore beds in the southeastern portion of the country. The road will be about eight miles long, and the intention is to finish it, if possible, the present year. The building of this road will insure the starting up of the idle furnaces, which will be a great advantage to the city and county, besides developing a vast quantity of mineral wealth.

—The English papers say that the divers engaged on the American steamer Schiller, wrecked off Sicily two years since, have ceased their labors for this year, but, confident that much of the specie and bullion in the hull can still be got out, will resume operations as soon as the weather next year will permit. Mr. Allen, of Liverpool, is the chief of the diving staff, and has arrived on the Cornish coast.—*Iron Age*, xx, 18.

Scientific Surveys.—A letter written to Dr. Hayden by Sir Joseph Hooker, Director of the Royal Botanical Gardens at Kew, a day or two before his departure for England, outlines some important botanical work projected by himself and Dr. Gray, of Harvard. The following is an extract of the letter:

"We shall hope to take Colorado as a central point for opening out the main features of the flora of North America, and discuss them in relation to it and to one another in a rather detailed manner. We hope to bring out clearly the contracts between the Rocky Mountain flora and that of the forest regions of the East and West, including in the botanically defined Rocky Mountain region the whole of Central unforested North America from the west of the Mississippi to the base of the Sierra Nevadas. The region thus defined will be divided into, first, an Eastern plain; second, a central Rocky Mountain district proper, extending from Pike's Peak to the Wasatch Range; third, a Western district, that will include the desert country. The Rocky Mountain proper district again will be divided, vertically, into an Alpine, and, perhaps, a sub-Alpine and lowland flora. The comparison of the flora with that of the mountain ranges of Asia and Europe will follow; and then we must see what we can do in the way of correllating any of the features with the Glacial epoch and Lesquereux's vegetable fossils."

Sir Joseph Hooker expects to return to the United States in a few years, for the purpose of making the flora of the Atlantic coast an object of special scientific research.

The Superintendent of the Coast Survey has been compelled, by want of means, to suspend some of his most important work in the field. Among the parties which have been called in are those engaged upon the resurvey of Long Island Sound, the regular surveys about New York harbor, the entrance to Delaware Bay and the mouth of the Mississippi River, the survey of the Gulf Stream, and also those engaged on the system of primary triangulation to determine points for assistant State surveys. This latter work has already been carried from Maine to Alabama, and has been very successfully utilized by New Hampshire, New York and other States. It will be almost entirely suspended during the coming of active work which begins in November. It is hardly hoped that any money will be available for its continuance before another year.—*N. Y. Tribune.*

The Industrial Future of the East.—In considering the question of Mongolian immigation, we have more than once expressed the opinion that the only serious injury which our workingmen could ever experience from Chinese cheap labor would come in the competition of the products of that labor when utilized at home. In other words, we believe that Japan and China are destined to become formidable competitors with this and other countries in the manufacture of goods for export. The vast supply of cheap and skillful labor in the East, not now employed in any useful or profitable production, will at some time attract capital to Japan and China for investment in manufacture. An indication of the probable correctness of this prediction, is found in the rapidity with which the Japanese have imitated the goods hitherto made for that market in Birmingham and other English cities. The importation of these goods is said to have practically ceased, and the market is now supplied chiefly with similar goods of Japanese manufacture. A correspondent of the Birmingham *Post*, writing from Yokohama, informs the mechanics of that city that competition with Japanese artisans is practically impossible. He says of them: "Frugal as badgers, industrious as bees, the Japs undersell every labor market they enter and outdo every civilized artisan at his own trade. Anyone who sees a Japanese carpenter at work, with his toes for a vise and his thighs and stomach for a bench, has seen tools well used and goods equal to European turned out. They will, in fact, become formidable rivals of all kinds of Western manufactures. The Japanese are always ready to learn, and to outvie everything that the West does, and this they do with less food, less air, less clothing and less comfort than any civilized workman." The writer further states that he was offered a large order for Birmingham goods at a price at which he would lose about 10 per cent.; yet a factory at Osaka took the order and made the goods. These facts are full of unpleasant suggestion to manufacturers depending upon the high-priced labor of Occidental countries. When the spirit of progress shall have begun to thrill the sluggish pulse of Oriental civilization, the results will surprise the world.—*Iron Age*, xx, 15.

Wooden Pavements.—The Pittsburg *Dispatch* says: "The duration of wooden pavements, and least of the Nicholson and Miller type, appears to be about seven years under the regular city travel. This was demonstrated in the case of Fifth avenue and Wood street, and now finds further instance on Penn avenue, in the old Lawrenceville district. It was represented by the patentees and agents of these pavements that they would outlive the recollection of the oldest inhabitant—but the fact is they do not run quite as long as the bonds issued for their construction.—*Engineering News*, iv, 270.

Horse Flesh as Food.—The butchers of Paris slaughtered during the first six months of 1877, for consumption 5,283 horses, donkeys and mules, as compared with, 4,422 during the corresponding year of 1876. Hippophayism appears therefore to be on the increase. There are over 50 butcher shops in Paris where horse flesh is sold.

—There is said to be no wood more beautiful for ornamental cabinet work than the curled pine of Florida. It is sought for by European manufacturers of furniture, and much of it has gone forward from Pensacola. It is very difficult to work, and must be handled by the best mechanics with the best tools; but the results repay the cure and skill expended.—*American Builder*, xiii, 239.

MANUFACTURING AND INDUSTRIAL NOTES.

The Wicks Manufacturing Co., Worcester, have set a boiler with the Jarvis furnace, and it gives so much satisfaction that George Compton has ordered one of his boilers set in that way at his loom works.

—The Wason Manufacturing Company, at Springfield, Mass., recently sent fifty car wheels to the Grand Trunk Railroad, as a sample of their work, and shortly an order came back for 1,500 of the same sort. They are also at work on a lot of hay-cars for another road.

—The wooden bridge from Holyoke to South Hadley Falls, across the Connecticut, which was built in 1870, and cost $141,000, is so shaky that it is unsafe. A good iron bridge would have been put in at the time for $160,000 by the National Bridge Company.

—The Cambria Iron Works, at Johnstown, are furnishing the rails for the Pittsburg, Wheeling and Kentucky Railway.

—It is stated that the various shops at Paterson, New Jersey, have received orders to build fifty-six locomotives within a comparatively short time.

—The Trenton *Gazette* says that the Trenton Iron Company rolled 40,000 pounds of No 4 wire rods—a little less than quarter of an inch in diameter in nine hours, one day recently. This, it says, is the largest product that ever has been turned out in this country, and probably in any other. The wire mill at Woolwich, England, turned out in one day about 44,800 lbs. five-sixteenth rods, but the product of the Trenton Iron Company equal to about 47,000 lbs. of five-sixteenths. The largest product that has ever been turned out, heretofore, in this country was at the Cleveland Rolling Mill, which was 37,850 lbs. This was hardly a fair product, as it was done with a double set of men—one gang relieving the other through the day.

—The display of W. D. Wood & Co., of planished sheet iron at the Pittsburg Exposition furnishes conclusive evidence of its excellence, and especially of the little effect dampness has upon it. The display was put in place at the beginning of the exposition, over a year ago. The building stands on the banks of the Alleghany, on what is known as Smoky Island, and during the high freshets of last spring the basement was flooded. Notwithstanding this, when the covering was removed this fall the iron was found in perfect condition, and is still on exhibition. The claim that this iron is superior to the Russian in all particulars seems well founded.—*Iron Age*, xx, 26.

—Paducah, Ky., is rejoicing over a prospective cotton factory. A Massachusetts manufacturer has made a proposition looking to the establishment of a manufactory there whose specialty shall be the production of cotton hosiery. The Paducah *News* gives the proposition a good word and urges the capitalists of that city to give the project a favorable consideration.—*Western Manufacturer*, iv, 560.

—Willard P. Ward is making two tons daily of 50 per cent. ferro-manganese at his furnace at Cartersville, Ga.

—The Water Valley (Miss.) Handle Company is making large quantities of axe and other tool handles.

—Among the recent productions of I. B. Williams & Son, belting and hose manufacturers, Dover, N. H., have been two 30-inch double belts 138 and 157 feet long, for a large manufacturing corporation in Fall River, and two 24-inch double belts, 145 and 160 feet long, for a large concern in Baltimore, Md.

—One of the largest cordage factories in New England, and the only one in Maine, is located at Bath. This manufacturing interest was established by G. & J. T. Donnell, 34 years ago, and the main building in which it is located is 1,100 feet long. The firm gives constant employment to 40 hands and turn out 3,000 lbs. of cordage per day, making a specialty of "gangs of cordage." Their works are filled with improved, machinery driven by a steam engine of 70 horse power

—Some 250,000 pistols have been made at Norwich this year. Orders are increasing and many of the works are running day and night. The Bridgeport Cartridge Works make some 700,000 cartridges a day. They have supplied Russia with 40,000,000, Turkey with 70,000,000, and have just got an order for 80,000,000 from Italy. The Russian and Turkish inspecting officers have been working side by side at the factory.

—A. C. Rand, of Rand & Waring, New York, has just shipped a small order of American (Manhattan) pig iron, to a firm in New Zealand, for trial, with a view to placing larger orders if satisfactory.

—In addition to the shipment of a locomotive-cylinder boring machine to S. America, noticed in our issue of week before last, Mr. L. B. Flanders, of Philadelphia, informs us that he has likewise lately shipped a 26 rotary valve seat planer, and a patent crank pin machine to the Dom Pedro II Railroad, E. of Brazil.

—The Tredegar Iron Works at Richmond, Va., are filling large contracts for railroad cars. The spike, plate and other mills are in full operation, and when the puddlers are all at work from 900 to 1000 men will be employed. There are cars ordered ahead which will keep the works busy for some time to come.

—The petroleum trade of the country has attained to enormous proportions, and there is scarcely a civilized spot on the face of the habitable globe to which this cheapest of all illuminators is not now shipped. There are now under engagement at New York, Philadelphia and Baltimore fully two hundred vessels to load with petroleum for various parts of the world. It is estimated that 20,000 oil wells have thus far been dug in Pennsylvania and West Virginia, at an aggregate cost of $192,000,000. They have yielded about 88,000,000 barrels of oil, valued at the wells at $300,000,000 or $400,000,000 at the seaboard.—*Louisville M'ch't and Manuf'r.*

—The principal business done at Connellsville, Pa., is the manufacture of coke, and the following furnaces are running to their utmost capacity: The Connellsville Gas Coal and Coke Company are running 255 ovens. The principal part of the coke is sent West to Omaha, Utah and Sacramento. The Connellsville Gas Coke Company are running 101 ovens; Col. Morgan's Coal and Coke Company, 110 ovens; Mr. Henry Clay Frick's Coal and Coke Company, 200 furnaces, and Laughlin & Co., 100 ovens, which gives employment to a large number of laboring men.—*Saward's Coal Trade Journal*, xiv, 170.

—All the cotton mills in Georgia and North Carolina are running on full time, and are keeping a large number of hands in employment. Wages in the Southern cotton mills are from 20 to 30 per cent. less than in the Eastern and Middle States, and they declare dividends of 13 and 14 per cent.

—The Akron, O., Knife Works have resumed operations.

—The Vulcan Mill, St. Louis, is running double turn.

—It is stated the Bellaire (Ohio) Window Glass Works shipped fifty thousand boxes of glass last month.

—The Pittsburg Exposition closed Saturday night. It has been very successful.

—A company under the name of the Bangor and Bluehill Mining Company has been organized in Bangor, with a capital of $200,000. They have commenced operations in the Bluehill copper mine, and the ore is to be sent to Philadelphia to be smelted.

—A contract has just been let at Amsterdam for the delivery of 20,000 iron sleepers to the Netherlands state railways.....The officers of the Grand Trunk R. R. have decided to build machine shops at the Fort Gratiot station, to cost $40,000.....A narrow gauge R. R. connecting Straitsville and Zanesville, Ohio, at an average cost of $12,000 per mile is on the tapis.....The new steam street car purchased by the Mt. Auburn Street Railroad Co., of Cincinnati, of the Baldwin Locomotives Works, of Philadelphia, was tested on the line of the company in the former city, on the 26th ult., and pronounced a perfect success.....The Keystone Saw Works of Henry Disston & Sons, Philadelphia, are unusually busy, having a larger demand than usual for their varied products.....Lindsay & McCutcheons, sheet-iron manufacturers, of Pittsburg, are running their works double turn, to keep up with the growing demand for their products.....The Moline (Ill.) *Review* informs us that the Barnard & Leas Manufacturing Company, of that city, recently shipped a separator to Liverpool, Eng., and a brush scouring machine to Cork, Ireland. .....The Danfroth Machine Works, Paterson, N. J., have a heavy order amounting to $90,000 for South American cotton machinery.....During the last week in August there were shipped from the Fairbanks Scale Works, St. Johnsbury, Vt., thirteen car loads of scales, and orders were received for 700 more scales than they made.....The button manufacturers of Waterbury, Conn., and Easthampton, Mass., produce annually about a quarter of a million dollars' worth of buttons.

EDITORIAL CORRESPONDENCE.

STEAM TO SOUTH AMERICA.—SUBSIDY OR NO SUBSIDY.

EDS. POLYTECHNIC REVIEW:—

We have talked and heard so much about subsidies that at last most people believe that such enterprises could not be undertaken without them. If we consider what the legislative expense of obtaining a subsidy is, and how much corruption and demoralization it carries into our legislative bodies and their surroundings, it is certainly no blessing.

But, to come to bottom facts, let us ask, "Why were subsidies originally given?" If we go back to the early days of steam navigation we find that the machinery of a steamer was heavy and bulky, taking up perhaps one-third of the vessel, thus leaving comparatively little room for paying load The latter was further encroached upon by the space required for fuel, while as the consumption in those times was at least five times that of our present modern marine engines, demanded considerable room, even for short distances. Under such conditions the British government found it necessary to give large subsidies, both to keep up communications that were imperatively demanded and also to encourage further progress; and as regards the latter it has certainly succeeded, if we look at the immense mercantile marine of Great Britain, and their magnificent ship-building establishments.

With improvements in the marine engine, the shorter lines soon became self sustaining, of which we have an example in the brilliant success of the two German lines (Hamburg and Bremen) to New York, which have never received any subsidy, and yet at times have paid a dividend of twenty per cent. per annum.

The general introduction of the compound engine created a new era in steam navigation. Thousands of steamers are now built in England that are able, on account of their economy in fuel, to go to almost any part of the globe without any subsidy whatever and pay a good profit. Among the many cases that have come under my personal observation is that of a small seaport on the Baltic, where a company owns a fleet of eight freight steamers of two thousand tons each, which they send to all parts of the globe. They are constantly employed, and have paid dividends of from ten to twenty per cent. We have in this country all the requisites necessary for the production of first-class steamships. We have iron of excellent quality, workmen superior to any in the old world, and all the experience gained by other nations are at our service. We can build and manage ships as cheap as any nation. So why should we wait for government aid, which anyhow will only be given grudgingly, and, being contrary to the spirit of our institution, will be generally opposed by all not directly interested! Some time ago I sent communications to several papers stating that a fleet of suitable steam colliers could deliver our coal at Pernambuco for a freight of $4 per ton, at Rio for $5.25, returning in ballast. If they could secure a return freight the conditions would of course be much more favorable. As English coal costs from $10 to $12 per ton in Brazil, there ought to be a good market there, especially for anthracite, which is so much superior to the ordinary English steam coal. I would state that the above figures are deducted from practical experience gained by me in connection with steam shipping in Europe, and also with the very efficient fleet of steam colliers of the Philadelphia and Reading Railroad Company. With regard to a passenger and freight line to Rio, a semi-monthly service could be kept up with five steamers: Cost of five steamers, $2,500,000; cargo capacity, 2500 tons; passengers, first-class, 70; speed, twelve miles per hour. There would be 48 single trips per year, and if only 40 passengers and 1500 tons cargo were taken on each trip, expenses would be paid as follows:

Cost of single trip including repairs, insurance, depreciation and 6 per cent. on capital, -	$15,000
40 passengers at $150, - - -	$6,000
1500 tons of cargo, average freight $6, -	9,000
	$15,000

The charge assumed for passage is in uniformity with those usually made proportional to distance, and the charge for freight is less than by sailing vessels, although it is well known that shippers are willing to pay more freight to steamers. I hope thot my remarks may throw some light on this important question, and shall be glad to give further information.

J. HAUG,
Marine Architect and Engineer.

PHILADELPHIA, Oct. 13, 1877.

PHILA., Oct. 16, 1877.

EDITORS POLYTECHNIC REVIEW:—

Early last spring I wrote to you for information concerning the Salmon brick, used in building the second and third stories of our place of business. These bricks, it was found were getting very soft, so much so that particles would drop off with the shaking of the rooms. The question asked you was whether you knew of anything that could be used for harding said bricks (which it was at first believed became soft from effects of weather), in your REVIEW, No. 14, vol. 3, 1877, I found receipt as follows: Clean the walls of all the loose particles with a broom, then give said walls three coats solution of silicate of soda, and one coat of whitewash. This I carried out (except the whitewashing part, which I omitted, as it would have given too much of a glare). In a few days afterwards, I found that, although it (silicate of soda) did not penetrate very far into the bricks, they became hard enough to remain together. I think that another coat or two would make them still harder. I took about five pounds of dry silicate of soda and put in about a three gallon vessel, filled it up with water and boiled it a few minutes, then put it on the walls (solution still hot) with a whitewash brush. I filled the vessel up three times with water, boiled it each time, but did not put any more dry silicate of soda in the vessel, on account of the five pounds not all dissolving. A day or two after that the brick had the appearance of being coated with a thin whitewash. Every place the solution touched it left a white coating, that is on the bricks, but the floor it made very clean; and I think would be a very good article for household purposes for cleaning the floor and other kinds of wood work. I suppose the cost of the job, labor excluded, was about fifty cents, for about two hundred feet square, of brick work, giving the above number of feet three coats of the silicate.

FRANK LANGE,
1406 Germantown Ave., Phila.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, OCTOBER 27, 1877. No. 17.

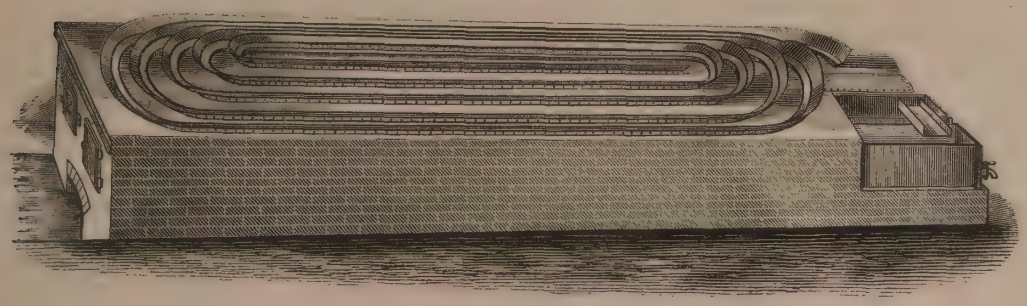


Fig. 1.

Fig. 2.

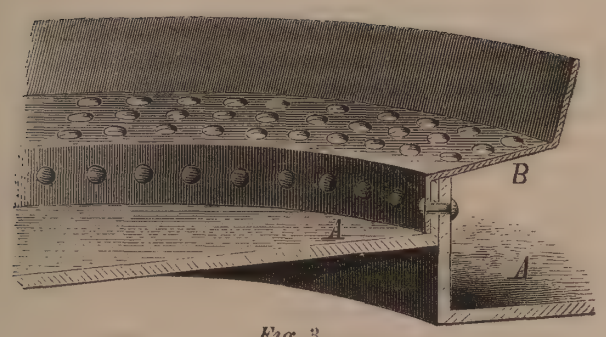


Fig. 3.

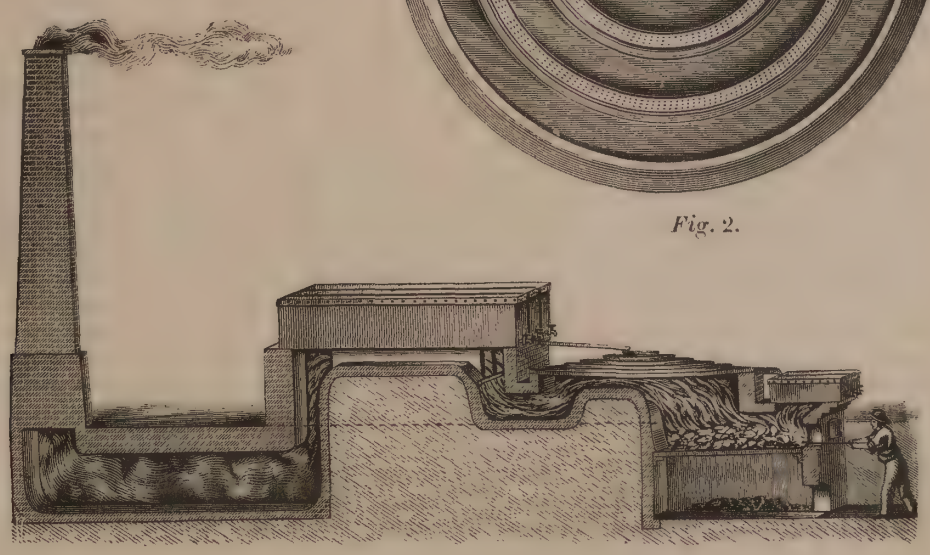


Fig. 4.

GUARDIOLA'S IMPROVED SUGAR MACHINES.

The accompanying engravings represent very fairly certain mechanical improvements in sugar machinery, designed to effect the evaporation of the defecated juice rapidly and economically. The rapidity with which the several operations are carried on, is one of the prime conditions of success in sugar manufacture, inasmuch as the quantity of crystallizable sugar obtained depends very much upon the speed with which the evaporation is conducted. The employment of vacuum pans has largely obviated the inconveniences and losses entailed upon the old plan of employing open ventilating pans; but the first cost of the vacuum apparatus is very great, it demands skillful labor, and the use of large filters of animal charcoal for removing the impurities of the liquor, revivifying kilns, &c.

The apparatus here described is designed to remedy these difficulties and disadvantages. A strainer that follows the whole length of the channel is provided for the purpose of retaining the impurities of the liquid, and the result is affirmed to be, that while none of the juice is lost, a clear stream of syrup runs out of the end of the channel, leaving but little work for the filters to do. The impurities left on the strainer are easily removed.

Where the open pans with direct fire are used, the evaporation is about 6 lbs. of water per hour per square foot of heating surface, when the train is properly set. The open steam pan, with double bottoms and steam pressure of 50 lbs., the duty is about 13 lbs. of water per hour; and with a copper coil, about 22 lbs.

On the most approved vacuum apparatus, the evaporative duty is as high as 30 to 33 lbs. of water per hour for every square foot of surface.

The helix evaporator is claimed to attain the same high evaporative duty as the most approved vacuum apparatus, and with considerable (40 per cent.) economy of fuel, demanding but little filtration, and, as the operations are more rapidly conducted, a notable saving of time, labor and material. In the directions given for the use of the helix evaporator, it is claimed that the density of the syrup is always the same, on an equable supply of the defecated juice, where a constant degree of heat is maintained in the furnace. The caution is given, not to carry the density beyond 25° to 30° B., to avoid the coloring or burning of the sugar.

The evaporator is made of two shapes—one oval and the other round—and of several sizes, according to demand.

The engravings given with this show the appearance and construction of the two forms of the apparatus. Fig. 4 shows a train for a sugar evaporator arranged upon this system, which will be understood by the following description: This train is composed of three defecating pans, *A*, set on the same level and on separate flues, a *helix* evaporator, *B*, and a double flat pan, *C*; the latter being used to regulate with greater nicety the density of the syrup. This battery is so arranged that one pan discharges into the next below without lifting the juice. The three defecators keep the helix evaporator constantly supplied with juice—while one is being emptied, another is filling up, and the third is in course of defecation, so that there is never a lack of the liquid.

After filling up the three defecators, a small quantity of water is allowed to run in the channel of the helix and into the double pan, *C*; the fires are at once lighted to give the proper heat to the juice in the defacators. As soon as one of the defecators is ready, the water is stopped, and in its place the defecated juice is run along the helix, care being taken never to allow the channel to be bare. The compartments of the double pan are emptied in order to receive the syrups supplied by the helix. When work is stopped, a small stream of water is run right behind the juice; this water protects the metal from burning, and at the same time it is used to clean the apparatus.

When the defecated juice begins to run and boil in this helix-evaporator, the natural impurities of these liquids coagulate and rise with the froth, spreading over the continuous strainer, and there they are deposited, allowing the clear juice to pass through the small holes and fall into the channel below. In this manner the impurities of the juice are set aside, and removed without causing the loss of a drop of liquid; in fact, this helix evaporator suppresses entirely the "scums."

The syrup that comes out of this evaporator, in a continuous jet, is so pure and so rich in crystallizable sugar that it leaves very little to do for the filters.

The quantity of juice supplied to the helix and the condition of the fire under the pan, will terminate the density of the syrup; this should receive its last concentration in a separate pan. The fire must be kept, as much as possible, under the evaporator, to receive the full benefit of it. When the syrup has reached the desired degree of density in the double pan, the hot syrup might be directed either into bag or bone-black filters. From the filters, the syrup is put into an open "striking" pan or into a vacuum pan to receive the last concentration. A copper filting pan, for direct fire, with a rolling damper, is provided for this purpose, which cuts off the fire instantaneously from under the pan, and by that means prevents the charring of the sugar.

W.

UNDERGROUND TELEGRAPHY IN GERMANY.

Entire success is claimed for the enterprise of subterranean telegraphy in Germany. The wires between Berlin and Halle have been in use for twelve months, and their conducting power has increased, no fault having yet been detected in the insulation. The line is formed by a cable of seven thin copper wires twisted together so as form a single conductor; they are cased in india-rubber and laid in a trench which is dug afterward filled in by a steam excavator. The trench dug by this machine is uniform; it is one metre deep and half a metre wide. The work in ordinary soil is said to go forward with great expedition, and underground wires will soon be laid between all the chief cities. Germany has much the start of us in this most necessary improvement. So long as we trust to telegraph poles we must expect to have half the wires down in such a storm as that of October 11th; and at all times must expect that a mob, a fire or a railway accident may interrupt our telegraphic communication just at the time and place where it is most needed.—*N. Y. Tribune.*

OXYGENATED BLAST FOR HEATING AND METALLURGICAL OPERATIONS.

The course of improvement in economical steam generation was at first directed simply to increasing the amount of heating surface in steam boilers by return flues, then by submerged return flues, the tubular and tubulous systems, &c. The heat generated has been economized by carefully felting the boiler, and the hot gases in the stack have been employed to heat the feed-water to a high degree. But the question of more perfect combustion seems to have been an after-thought, and all kinds of devices have been proposed, to make the combustion complete within the range of absorption of the heating surface.

Combustion has been coaxed by high chimneys and the exhaust of engines, or driven by jets of live steam; the effect being to increase the generation in a given time, but also to increase the fuel consumption in much greater proportion. The trouble seems to be with the amount, character and place of the air supply. Too little air chokes the fire and either black smoke or carbonic oxide is formed.

Too much cold air chills the fire and the flues. Cold air, let in under the grate, will not pass through a very thick fire, or the carbonic acid formed in the bottom layer is robbed of its oxygen by the upper layer.

Air has been let in at the fire level, somewhat above this level, and at the bridge wall (when the boiler is horizontal). To avoid the chilling effect of cold air in large volumes, automatic stokers have been designed, and the draft has been heated, but the latter increases the relative volume of air supply with the corresponding decrease in its actual weight. About the whole amount of it is that the 79 per cent., by weight, of nitrogen in the air is in the way and is drowning the fire. Very luckily for us this proportion is so large, as it prevents the fire from tyranizing over us by conflagrations any more than at present; but when we have this agent harnessed down surely a spur is of use.

But perhaps the most radical departure from the beaten track of invention in this field, and certainly the most interesting and suggestive experiment for effecting better and more economical results than are obtained in the ordinary practice of burning fuel in furnaces, boilers, &c., for general industrial and metallurgical purposes, is a process introduced and lately patented in this and several European countries by Mr. Charles Hornbostel, of New York, by which oxygen is automatically imparted to the blast supplied to boilers, heating, puddling, blast furnaces and the like. The theory upon which the inventor has proceeded is based upon the observation that the prime elements of economy and effectiveness in consuming fuel, reside in the rapidity of combustion and its completeness, and as both of these elements will have their maximum value where combustion occurs in an atmosphere of pure oxygen, in which the phenomenon of combustion will be manifested in its most exalted degree, the inference would appear to be waranted that the economical addition of this vital agent to the blast of furnace and forge fires should show correspondingly superior results on the score of economy and effectiveness. There is, however, a limit which the conditions of practice impose upon the extent to which the conclusion above announced may be advantageously carried.

While it is strictly true that the intensity of combustion will be notably augmented in an atmosphere rich in oxygen, and augmented in the direct proportion to its freedom from nitrogen or other diluents, it is also true, that the destruction of the apparatus and devices in which the combustion is carried on will, as the proportion of oxygen rises, soon become so rapid as to off-set this advantage, and on the other hand, the extremest possible rapidity of combustion which could be attained in an atmosphere of pure oxygen, is not compatible with the highest economy. Physical causes, connected with the properties of the metals employed in the construction of furnaces and attachments in which the combustion of fuel is effected, and which are in the nature of things *impossible* of remedy, we refer here to the fact established by the investigations of the Franklin Institute Committee in 1835, that the maximum evaporative effectiveness of iron plates for water evaporation is attained at about 600° F.

It is therefore obvious that where the object of combustion is simply the transference of heat, as in the steam boiler, any increase of the intensity of combustion above a certain point (the point of maximum evaporative efficiency above referred to) is not desirable, inasmuch as, presuming the velocity of the gases through the furnace, to remain the same, and this factor therefore to be out of consideration, the excessive heating of the conducting surfaces resulting from a greater rapidity of combustion, is not attended with a corresponding gain in evaporative effectiveness—or, to state the matter differently, an increase in the intensity of combustion in the case of the steam boiler, beyond the point of maximum, conductive capacity of the heating surfaces is not economical; the proportion of wasted heat being so much greater in comparison with the increased temperature attained, that there is and actual loss of useful heating effect per pound of coal consumed, when compared with that accomplished by a more moderate combustion.

A moderate increase of the intensity, however, in the case of steam generators, will in the vast majority of cases be advantageous, since owing to various mechanical defects of construction difficult of remedy, the conditions of maximum economy are not maintained, except at a few points upon the heating surfaces. So that the introduction of a blast containing a small excess of oxygen above the normal quantity may, and doubtless will, be found to effect an increase of steaming capacity, which could not be obtained by simply increasing the volume of air supplied to the furnace. These theoretical considerations are of vital importance in treating of the proposal of Mr. Hornbostel to use an oxygenated blast without practically increasing the volume of the blast or the rate of passage of the furnace gases through the combustion chamber, and appear to warrant the conclusion that if the added oxygen is limited to a few per cent. *ceteris paribus*, a notable increase of useful heating effect may be confidently anticipated to result; but that maximum point having been reached, any increase of oxygenation, so far from continuing to be advantageous, will be positively wasteful. Mr. Hornbostel's system, as will be seen further on, possesses the feature that the degree of oxygenation of his blast is under perfect control. The proportion of free oxygen liberated in the generating chamber not exceeding even where the maximum quantity is desired, a few per cent.

So far, therefore, as we may judge from general considerations, the system should, when properly understood and applied, work advantageously with steam generators. In the case of heating furnaces, forge fires and the like, where a concentrated heat is the only consideration of importance, there would appear to be doubt but that the addition of free oxygen to the blast will prove highly advantageous; and in the blast furnace, and other metallurgical apparatus, where important chemical operations are involved, depending for their rapidity and completeness upon a sustained and extremely intense combustion, it appears to us that an oxygenated blast should manifest its maximum useful effect. From these considerations the reader will be prepared to form a judgment of the novel plan of Mr. Hornbostel, which can be best given in the language of the specification, to-wit:

"This invention relates to an improved method of increasing the combustion of fuel in various classes of furnaces, for the purpose of economizing the fuel and intensifying the heat and facilitating various metallurgical operations, such as the reduction of ore and the melting, puddling and working of metals.

This object has heretofore been accomplished by increasing the volume of air supplied to the furnace by means of a bellows, fan or other blast-producing machinery; but in such methods, in order to supply the full amount of oxygen, necessary to ensure complete combustion and obtain the greatest heating effect of the fuel, it has been found necessary to employ a large volume of air, necessitating the heating of the useless volume of nitrogen contained therein, which materially lessens the effectiveness of the operation. My invention is designed to overcome this objection, and also to oxydize and carry off the impurities present in most of the varieties of fuel, such as sulphur, &c., which materially interfere with metallurgical operations, and to assist in the combustion of fuel.

By the ordinary process of preparing oxygen from black oxide of manganese and sulphuric acid, the complete decomposition of the materials can only be effected by the aid of heat, which, besides being expensive and requiring refractory and highly non-corrosive vessels for its generation, offers no effective means of applying the gas after it is generated to the purposes intended.

I have discovered that by bringing a current of air under pressure into violent contact with a mixture of sulphuric acid and black oxide of manganese, or by passing the air through or into violent contact with an extended surface of the same, that complete decomposition of the materials can be effected without the use of heat, and at the same time the gas can be conveniently and continuously applied to metallurgical operations and to assist combustion of fuel in furnaces.

In carrying out my invention, I mix the sulphuric acid and black oxide of manganese in the proper proportions, which may be the same as usually employed, although for convenience I prefer to employ the manganese slightly in excess of the ordinary proportions, so as to form a thicker mass, taking care to have the black oxide of manganese as pure and as free from metallic manganese as possible, in order to form no unnecessary residium in the vessels. The materials I place in a vessel of any desired construction, into which leads a pipe from a blast apparatus which projects downward towards the bottom upon which the materials are placed, or enters said vessel in such a manner as to force the air violently into contact with the materials or through it. From the top or other convenient part of the vessel extends a pipe by which the admixture of air and gas is conducted to the place of use.

Upon forcing a current of air through the induction pipe so as to violently agitate the mass of materials or pass through it, or otherwise come into contact with every particle of the same, the decomposition will commence and continue until thoroughly completed without the assistance of heat, and the gas will be taken up as it is generated and thoroughly commingled with the air, and in this condition can be effectively applied to the intended purposes.

By my improved process I am thus enabled to produce the gas without the aid of heat, which effects a material saving in expense and enables me to employ in the construction of the generating vessels comparatively inexpensive materials, such as wood and lead instead of the expensive glass or platinum vessels heretofore found necessary, and at the same time afford an effective means of applying the gas continuously while the charge lasts, and when exhausted the charge may be quickly replaced and the operation continued as before.

What I claim and desire to secure by letters patent, is:

1. The process herein described of producing oxygen for metallurgical purposes, and the combustion of fuel by conducting a current of air under pressure through or into violent contact with a mixture of black oxide of manganese and sulphuric acids substantially as described.

2. The process herein described by applying oxygen gas to metallurgical operations, and to assist in the combustion of fuel by conducting a current of air under pressure through or into violent contact with a mixture of black oxide of manganese and sulphuric acid, substantially as described above."

We shall be pleased to notice, when opportunity occurs, any practical developments of this interesting novelty, and, in the meantime, may notice the fact from evidence submitted to us that the system has been tried with very satisfactory results by a number of leading industrial establishments, whose endorsement of its advantages is, in most instances, unqualified. W.

THE CONDITION OF OUR BLAST FURNACES.

The New York *Iron Age* of October 18th published a detailed statement of the condition of the blast furnaces in the United States on October 1st, of which we make the following condensation: Number of charcoal furnaces reported in blast, 89, with a weekly capacity of 7,887 tons; out of blast 176, with a weekly capacity of 12,957 tons. Number of anthracite furnaces reported in blast, 86, with a weekly capacity of 17,067 tons; out of blast, 140, with a weekly capacity of 25,268 tons. Number of bituminous or coke furnaces reported in blast, 77, with a weekly capacity of 19,670 tons; out of blast, 136, with a weekly capacity of 29,780 tons. At or near October 1st, for the past four years, the percentage of furnaces in blast is given as follows: 1877, charcoal, 34 per cent., anthracite, 38, and bituminous, 36; 1876, charcoal, 32 per cent., anthracite, 31, and bituminous, 36; 1875, charcoal, 40 per cent., anthracite, 42, and bituminous, 45; 1874, charcoal, 69 per cent., anthracite, 61, and bituminous, 46. These figures indicate that more charcoal and anthracite furnaces are in blast in 1877 htan there were in 1876, but that in bituminous furnaces there has been no change.—*Bulletin*, xi, 284.

ON THE TEETH OF GEAR-WHEELS.—II.

SIDE-NOTES FROM THE SCHOOL OF MECHANICAL ENGINEERING OF THE ILLINOIS INDUSTRIAL UNIVERSITY.

Let us consider, in what follows, more convenient

PRACTICAL METHODS OF LAYING OUT GEAR-TEETH WITH RADIAL FLANKS.

1st. A good practical method is by use of templets shown in Fig. 2. They may be formed of sheets of wood.

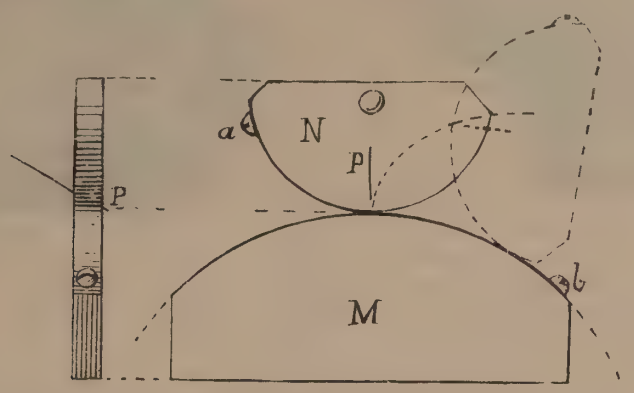


Fig. 2.

M being cut carefully to conform with the pitch-circle for which we want the teeth, and *N* to a circle whose diameter is the radius of the pitch-circle which works into *M*, in accordance with the fundamental principle arrived at in a previous article. Fasten the describing point *P* to *N* in such a way that it is exactly at the periphery. A hole may be pierced diagonally, and the awl or pencil set as shown.

While *M* is held firmly against the drawing, roll *N* upon it. Then will *P* trace the desired curve, the latter being right-handed or left-handed, for one side of the tooth or the other, according to direction of rolling. The templets are somewhat liable to slip on each other, which annoyance may be partially remedied by chalking their edges, or by rubbing their edges with powdered rosin. A better way is by attaching a light spring fastened by screws *a b*, and winding upon one templet as it unwinds from the other. Or even a slip of paper thumbtacked, or stuck with mucilage, will answer a good purpose. *N* may be rolled either way with the one strip *a b*, and when thus connected, any number of faces may be easily drawn in proper relative position for delineating the gear. To do it, lay off the pitch and tooth thicknesses on the pitch line, placing *M* coincident upon it. With a point on *M* at a pitch-line division, draw one face curve. Then move *M* along the pitch-line to the next division, and draw another face-curve, taking care to turn the proper ones toward each other. The connecting ribbon, *a b*, preserves the relation of *N* to *M*, so that when *M* moves a tooth or space *N* does likewise.

2d. The epicycloidal machine is an extremely valuable aid in executing very small cut gearing. It has been in use in watch factories, and, to a slight extent, in machine shops. It is a machine which makes systematic use of templets, on the same principle as above, but instead of simply delineating the tooth, forms a steel tooth for making the tooth-cutters.

3d. To delineate the tooth on the drawing-board with ordinary drawing instruments, the describing circle *B C*, (Fig. 1), may be drawn in several positions as shown in Fig. 3, as *bc*, *de*, *fg*, &c. Then, assuming *a* as the starting point of the face, step off with spacing-dividers a number of steps to where the circle *c b* touches the pitch-line, and then back on *b c* the same number of steps to *c*. Then *c* will be a point in the curve sought, Again, step from *a* to *d*, and back an equal number to *e*, and similarly to *f* and to *g*. Then *a c e g* will be the required epicycloid. The proof of this lies in the fact that the arcs *ab bc*, or *ad de*, &c., which have rolled in mutual contact, will be equal to each other.

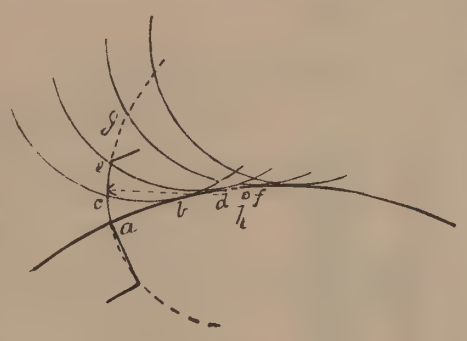


Fig. 3.

In very large teeth several points should be determined within the limits of the tooth-face, but in smaller teeth the curve cannot be seen to differ appreciably from a circular arc, and three points, *a c e*, will determine that circle. Its centre *h* may be easily found, and a circle struck through this centre point, and concentric with the pitch line will contain the centres of the circle arc faces for all the teeth, and will aid in striking them in. But this method of finding the substitute circle arc will be found wanting in accuracy, for the reason that the position of the points *c* and *e* depend upon so many steps of the dividers, &c.

4th. A more positive method is the following, found in works on gearing.* In Fig. 4, draw the describing circle *D*, and from the point of contact, *C*, the chord *CP*, so that *P* will come about at the middle of the face. From *P* draw the line *P E H* bisecting the radius *A C* in *E*. Then the radius of curvature *P F*, or radius of the epicycloid at *P* is, according to higher geometry, equal *PC* multiplied by *AD* and divided by *D E*, all of which lines can be readily and accurately drawn and measured in any given case. *F* will then be the centre for the approximate circle face, and *FP* will be the radius. With these we may proceed as in 2d above.

If preferred, *F* may be found by a purely graphical operation by drawing *AH* parallel to *DP*, and *HF* parallel to *AD*.

5th. By odontographs and accompanying tables, teeth may be laid out conveniently, especially when large. The Willis odontograph was the first devised, and has been in general use for about forty years. It consists of a scale of twenty parts to the inch, counting each way from a point at which springs a ranch or tongue at an angle of 75½°. It serves to conveniently find the centres of circle arcs for faces and flanks of teeth. But as it produces radial flanks only for wheels of twelve teeth, its use will not be treated of here.

The recently-discovered *Templet Odntograph*, described in this journal for September 30th, 1876, and in *Van Nostrand's Engineering Magazine* for July 1876, and his *Science Series*, No. 24, and also in several German publications, is adapted for laying out all ordinary gearing with a very close degree of approximation, giving good results for teeth of six inches pitch. Its use for radial flanks simply requires the ratio of the diameters, or of the number of teeth of the wheels in question, and the number of teeth in the wheel sought. With these a tabular value is obtained, by which the odontograph is set on a tangent line, in position for drawing, directly, the face curve of tooth. But all the details of its use can not again be entered into here.

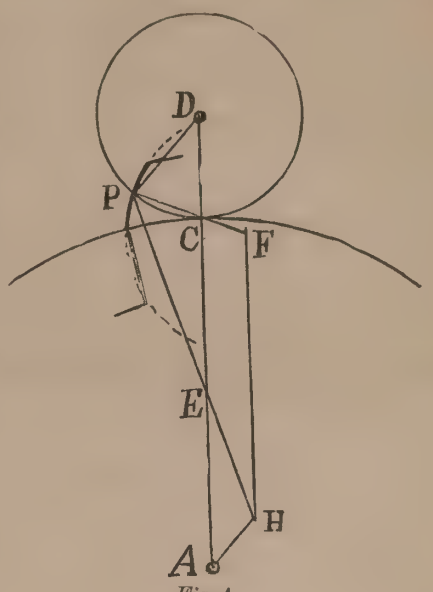


Fig. 4.

As to other methods for drawing radial flanked teeth, some simple ones which have been in quite common use by millwrights, are really worse than guesses, being mere blind, irrational jumps, such as using the middle point of one tooth as the centre of the circle arc face of the next, &c.

RELATIVE MERITS OF THE METHODS.

Of the five ways noticed, the first will give the best results for mere delineation for teeth of whatever size. It is convenient in requiring a knowledge, of only one fact in the theory of gearing, viz: as to the diameter of *N*. But it has a drawback in the inconvenient necessity of a new set of two pairs of templets for every pair of gears. It is, however, often used in machine and pattern shops, where there is some taste for smooth working gearing. The method is superior to all others for teeth of half inch pitch and less, except the epicycloidal machine, whose advantage consists in its forming the tool to be used in turning up the cutters. In the latter the final result cut-gearing, is obtained direct from theory by machinery, without being dependent upon a single *hand-and-eye* operation; whereas in the former, when the curve is drawn, a tool must be filed up by hand to fit it, from which the cutter is turned for the case of cut-gearing, or a templet is to be dressed by hand for marking out the curves on the wooden pattern in pattern-gearing. This pattern may consist of sheet tin, zinc, brass, or a thin piece of hard wood. It might properly be called a scribe templet, whereas those depicted in Fig. 2 may be termed delineating templets.

If by any means we could avoid the hand-and-eye process which produces the scribe templet, and still better, the process of delineation which gives the curve to dress the templet by, we ought, as in the case of the epicycloidal machine for cut-gearing, bring theory and practice into more intimate union. This, indeed, is effected by aid of the templet odontograph, which is itself the scribe templet, ready made, and hence the name, templet odontograph. Though the curve it produces is not precisely the epicycloid, still it comes much nearer to it than the workman with his hand-and eye operations, as will most likely be shown by a cut in a subsequent paper, and by far more closely approximating than the circle arc, which many regard as giving fair results in practice.

One point further should be noticed before dismissing radial flanks. Where a wheel has few teeth, the latter appear undercut and weak when the flanks are radial, but from the fact that the faces are quite strongly curved, and also that their bearing upon the flanks never extends farther down, from the pitch-line than from a third to a half of the length of the flank, "clearing curves," so called, may be sprung in, to which the tooth-bases may be thickened, thus very greatly adding to the strength of the teeth. Fig. 5 gives an example of the reinforcing of the teeth in this way; the full line departures from the radial theoretical flanks having been carefully determined so that the points of the teeth will but just clear them. The curves figured, therefore, give the teeth the maximum of this effect. The example has twelve and twenty-four teeth.

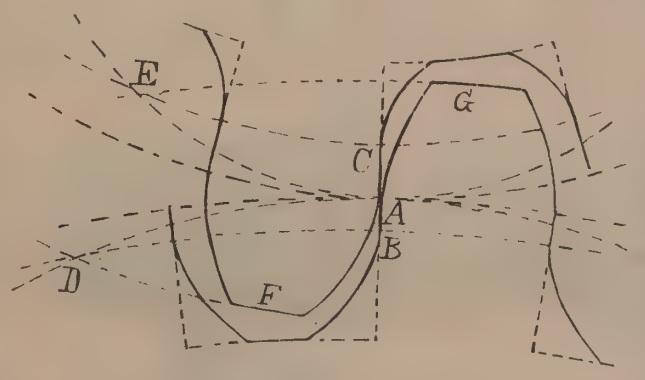


Fig. 5

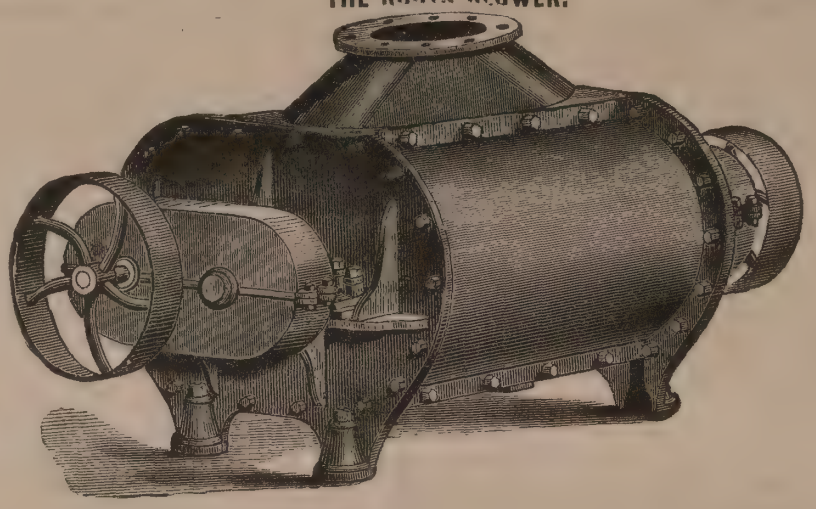
The initial point of the clearing curves is the distance of the point of quitting contact of a face and flank, from the pitch-line; or, in other words, it is at the junction of the addendum or point-circle of the teeth and the rolling-circle, as at *D* or *E* in the figure, *AD* and *AE* being the rolling-circles, and *DF* and *EG* the addendum circles. The circles *BD* and *CE* give the nearest approach of the clearing-curves to the pitch-lines. The strengthening thus given may, as it appears from the figure, be excessive. Guess curves may, therefore, be given to the lower parts of the flanks in practice, which will give the teeth very nearly the proportions desired. Small quarter circles are quite often put in, assumed by guess.

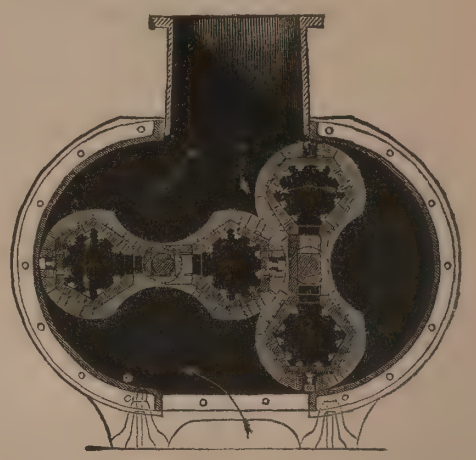
In a subsequent paper epicycloidal teeth with curved flanks will be considered.

S. W. ROBINSON.

*See Rankine; Machinery and Millwork, p. 57.

THE ROOTS BLOWER.





In this age of progress, any advance or improvement in existing devices for effecting a given purpose, is always hailed with satisfaction and encouragement. This is forcibly seen in the prominent mechanical and manufacturing industries, where valuable accretions to the general fund of knowledge are daily on the increase. As, for instance, in the manufacture of iron, where, from the primitive and diminutive efforts of the Hindoo, with the attendant slow and uncertain results, it has passed through successive stages to the expanded industry of the present day; all accomplished through slow but invaluable additions to the science of its manufacture,—such additions being the contributions of certain able intellects. As another instance we may take the watch-making industry, where, from the old time hand-fashioned "turnip"—the result of many days' labor—we have advanced to the handsome and accurate chronometer, which finds its birth and perfection in the manipulation of beautiful and ingenious machinery, and whose superiority is acknowledged the world over. It is just such progress as this, that has led to the development and perfection of pressure blowers, where, from the almost antideluvian box-skin blower of the Hindoo, we have progressed through the various methods of forcing air—from the fore-mentioned blower to the old-fashioned hand-bellows—from the hand-blowers to the piston and fan-blowers—from the fan-blower to the ultimatum—the pressure-blower.

It is not the object of the present article to dilate upon the comparative merits of fan and pressure blowing, except, in so far as it is necessary to establish the superiority of *pressure* over *fan* blowing—a fact so well attested, as to scarcely need demonstration.

An apparatus or machine devised for blowing purposes, should be capable of maintaining, as near as possible, a constant pressure in the discharge pipe, it should be positive in its action, should be as free from complication and liability to derangement as possible, and should be as economical in the consumption of power as the work performed will allow. In the comparison of the pressure and fan blowers, it will be seen, that the former must, of necessity, be positive in its action, as at each revolution it must displace a volume of air equal to the cubic capacity of its casing; the air must be forced out of the discharge pipe, as it has no other alternative, so that the power actually employed is utilized in forcing the air forward, or in driving the machine; consequently none is wasted upon air that is not actually used. Herein lies the positive character of the *pressure* blower.

With the *fan* blower, the blast produced *cannot* be as positive in its character, for here the blast will be directly proportional to the number of revolutions of the fan, and, as in each revolution, the fan acts upon air which only assists in the consumption of power, but which is not actually forced forward, the ratio of the work done, to the power employed, cannot be the most satisfactory.

This is easily accounted for by the fact that the air may have a slight momentum imparted to it, owing to its small specific gravity, but it is apparent that each blade of the fan, as it revolves, can retain little air before it, to be forced forward into the discharge, for the friction and adhesion of the air which surrounds the blades, for that which is actually propelled forward is so great that little can be retained before the blades to form an actual blast. It is like trying to shovel grain with a flat shovel—the grain falls off on all sides, and but little is retained to show for the work really involved—*fast* shoveling *may make* a *pretty respectable* showing, but it is *veryhard* work So it is with the Fan Blower—its effect depends upon its velocity—its velocity eats up the motive power.

That the pressure blower is the most economical device for the purpose intended, is evinced by the fact of it almost universal adoption, both in this country and abroad.

We are informed that over twenty-five hundred of these blowers are in use in England alone, and as many more on the Continent, over 5,000 in all in Europe. A Roots Blower has recently been constructed in England for ventilating the Chilton Colliery, having a capacity of 200,000 cubic feet per minute, and it is now in successful operation, and giving entire satisfaction. This, we believe, is the largest blower ever constructed. An account of this blower is published in the *London Engineer*, June 15th, 1877.

The slowness of speed with which the *Roots Blower does its work, and the positive and continuous character of its blast, places it in successful competition with the duplex cylindrical compressors for cupola furnaces, both with reference to work performed and cost involved.

The mechanical arrangement of it is simple, as a glance at Fig. 2 (which is a vertical section) will show. It will be seen that the blower acts by actual displacement of the air, which is taken in at the bottom of the casing, and is closed in by the wings of the revolvers, and forced into the discharge pipe. There is no possible escapement of the air backward, after once within the casing, for the revolvers are always in contact with each other, and nearly in contact with the walls of the cylinder —they just passing near enough to the casing to prevent leakage of air, thereby creating little or no friction, except that due to the thin film of air which is between the revolver and cylinder. The general appearance of the blower is shown in the perspective Fig. 1, where it will be seen that each revolver is rotated by a separate belt, by means of a pulley on the outer end of its shaft, the toothed gearing merely keeping the revolvers in their proper relation. The workmanship on the blower is of the first order. For all purposes, where either blast or exhaust is required, this blower is adapted; as in the ventilation of mines, buildings, tunnels, &c.; or for blast purposes in smith-shops, foundries and rolling mills, or for gas exhausting.

It is manufactured in sizes, whose delivering capacities vary from a minimum number of cubic inches of air, to 100,000 cu. ft. per minute. We are told that Mr. W. Ireland, the noted iron founder, made, through the aid of these blowers, a 250 ton anvil block in a little over eight hours, the melting of the iron being at the rate of 30 tons per hour.

S. F. P. JR.

*Patented and manufactured by P. H. & F. M. Roots, Connersville, Ind.

ATTACHMENT FOR INJECTORS.*

The object of this attachment is to secure the working of the injector with hot water, lifts its water, or feed under pressure. It is to be attached in the discharge pipe between the nozzle of the injector and the boiler, and consists of a lateral tube, *A*, introduced between the nozzle and a check valve, *B*, to the pipe which leads to the boiler.

In the tube *A*, sectional view Fig. 1, is placed a valve, *C*, the stem of which passes through guides, and which is held open by a spiral spring when the steam is shut off,

Fig. 1

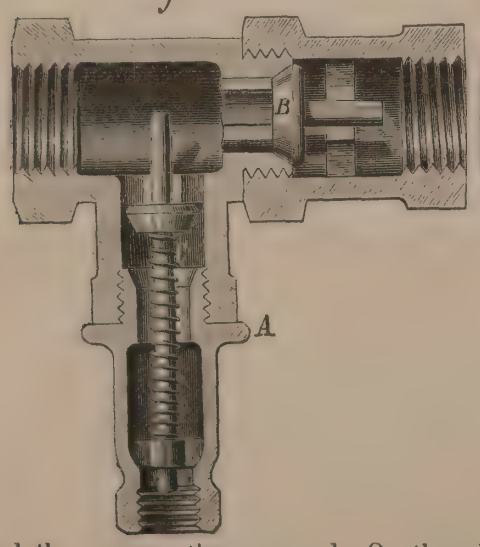
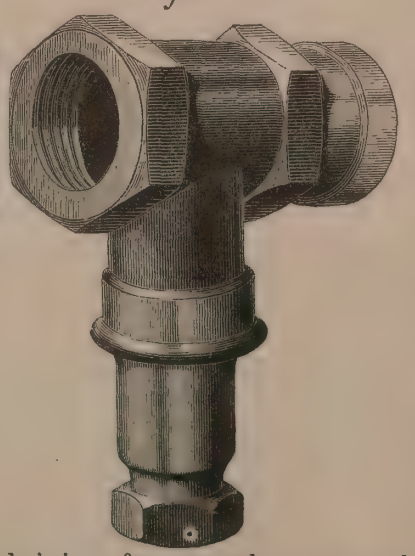


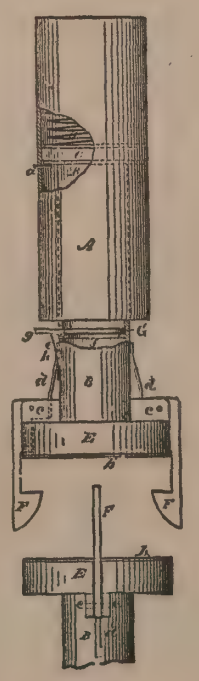
Fig. 2



and the pressure thus removed. On the admission of steam, and as soon as the pressure of the same becomes greater than the power of the spring, the valve *C* closes. The steam being thus prevented from escaping opens the check valve *B*, and passes into the boiler. The object of the check valve, placed between the overflow and the boiler, is to shut off the boiler pressure from the overflow.

*B. E. Lehman, manufacturer, Lehigh Valley Brass Works, Bethlehem, Pa.

IMPROVEMENT IN PIPE-COUPLINGS.*



The object of this invention is to provide a coupling for uniting the pipes used in conveying hot air for heatingcars or for air brakes, which is self-coupling and may be readily uncoupled.

Referring to the drawing, which is a side elevation of the coupling, *A* is a cylinder, that is attached to the end of the pipe that conveys the heated air. In this cylinder a tube, *B*, is placed, which is provided with a flange or collar, *C*, which accurately fits the cylinder, *A*, and is packed to insure an air-tight joint between it and the cylinder. *D* is a spring, that rests against an internal flange formed in the cylinder *A*, and presses against the collar *C*, throwing the tube *B* outward. A stop-pin, *a*, is placed in the cylinder *A*, for limiting the outward motionof the collar *C*. Upon the outer end of the tube *B* a flange, *E*, is formed, which is faced with an elastic packing surface, *b*. Catches *F* are pivoted in ears *c*, formed on the back of the flange, *E*, on opposite sides of the tube *B*, and are provided with square shoulders, that rest upon springs *d*, that are attached to the tube *B*. The springs serve to hold the catches *F* open or closed. In the tube *B* is a valve *G*, acting automatically against a seat, *f*, formed in the tube. A lever, *G*, is attached to the said valve, which strikes the edge of the cylinder *A*, as the tube *B* is forced into the said cylinder, and opens the valve, and when the tube *B* is thrown outward by the spring *D*, a spring, *h*, which is attached to the tube *B* and presses against the lever *g*, closes the valve.

The parts of the coupling are alike on each end of the car, and when the parts on adjacent cars are united, the catches *F* of one part engage the flange of the other. The tube *B* and flange *C* move longitudinally in the cylinders *A*, as the cars move toward or from each other in running, and when the couplings are detached the valve *G* closes automatically, preventing the escape of air.

*Rufus H. Moss, Salem, Oregon, Patentee.

JOHNSON'S VALVE GEAR.

No one who has ever written with regard to the link motion has as yet given a theoretical description, which would serve for a guide to an ordinary workman. Therefore, I have endeavored to place before the public an arrangement of valve gears which would give the desired motion, and at the same time do away with all irregularities occurring from the use of the link motion. On account of the link motion being in use for so long a period, it is hard work to show most men that it is faulty. But Prof. Rankine says: "When the stud is in any given position relatively to the link, let *O* represent the centre of the shaft, *OF* the forward eccentric radius, *OB* the backward, and *LO* be a straight line parallel to *FB*. In full forward gearing the half throw is *OF* and the angle of lead *LOF*; and on these and the lap the distribution of the steam depends. When the stud is at any intermediate position on the links, join *FB*, in which take the point *S* dividing that line in the same proportion in which the stud divides the length of the link. Then the motion of the valve will be *nearly* that corresponding to an eccentric radius *OS*, *provided* the eccentric rods are very long, compared with the eccentric radius."

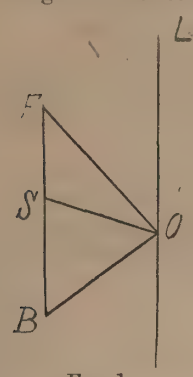
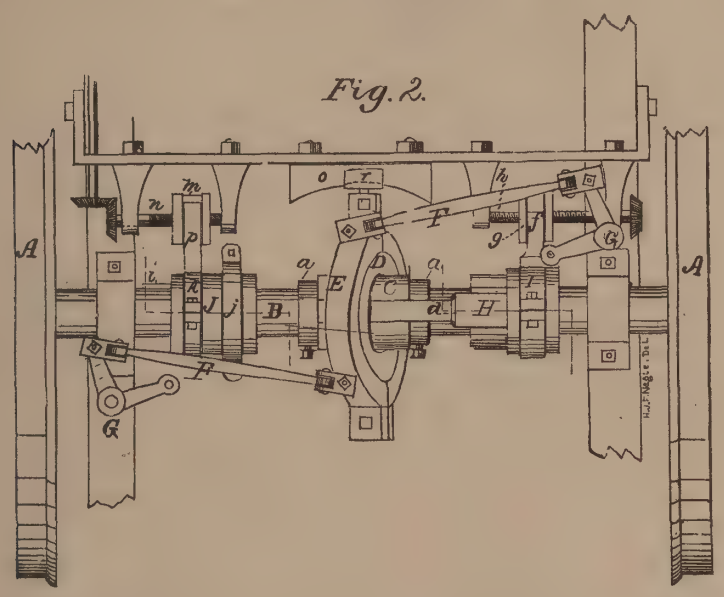


Fig. 1.

Again, in the treatise on Valve Gears, written by Hugo Bilgram, M. E., in THE POLYTECHNIC REVIEW, the author in the introduction says "the described link motion consists of a number of oscillating and reciprocating parts, and the exact law of the movement which the links in its several grades of gearing transmits to the slide valve is extraordinarily complicated. Our theoretical investigation will therefore be based upon a series of assumptions similar to those we made when considering the common slide valve. We shall thus disregard the effect of the oscillation or obliquity of the connecting rod and of the eccentric rods, and besides assume that every point of the links were moving in a right horizontal line, or in other words we shall overlook the vertical vibrations of any part of the link motion. A subsequent chapter will then treat of the modification that our theoretical results suffers from these neglected influences; and show a method for finding the means to make these influences *compensate each other. The mentioned

Fig. 2.



assumptions would imply a distortion of the link during its movement, and to keep these distortions within as small a margin as possible, we shall study the link while in its mid gear; when the link block will be operated by the centre of the link; it can then be demonstrated that the movement of any point of the link can be considered as though it were produced by a separate eccentric, and it remains now for us to find the position of this imaginary eccentric."

Now it will be seen from Prof. Rankine that angularity of the eccentric rods creates the fault. Also, the same with Hugo Bilgram's imaginary eccentric, which is a real movement combining itself with the fore-and-aft motion, so unevenly that it almost overthrows all theory in the workshop.

This, then, was one of my chief reasons for inventing a variable valve gear, which does away almost entirely with this uneven motion; *i. e.*, angularity of eccentric rods. Because the oscillation of collar *D* is so slight that the angularity caused by the arc, &c., that *D* describes, would be almost obliterated by the time that the motion was conducted to cranks *GG* (see Fig 2). The following diagram will explain:

Let *D* represent said collar, and *XY* points of extreme oscillation; draw a line from the centre of *D*, through *X*, at point *H* then the vibration of the rod would equal the distance *XH*. Now, as the rod only vibrates the distance of from *X* to *H*, it will be seen that by the time the motion reaches *G* it is almost pure, and in a full sized engine, having an 18 in. disc, eccentric rod 24 in., and 3 in. throw (of slide valve), the angularity of the rod from *X* to *H*, would be equal to about $\frac{1}{8}$ inch. Therefore, by the time crank *G* was reached, the motion might be called pure; for it could then only be detected by the aid of a microscope.

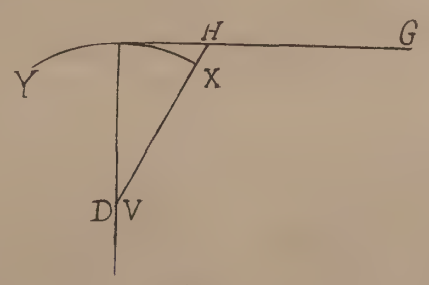


Fig. 3.

Drawings and desrciption of Johnson's Valve Gear having previously appeared in a copy of POLYTECHNIC REVIEW (March 24th, 1877), in an article by Mr. Haug, any further comments with regard to it would be useless.

WILBERFORCE JOHNSON.

*i. e., the dividing of impurity when setting valve.

ANOTHER SEWER-GAS TRAP.

Following our recent article on a device of this kind, we present herewith an illustration and description of a sewer-gas trap of quite different construction, the action and merits of which will appear from what follows: Of the importance of effective mechanical safeguards against the insidious dangers of sewer emanations, we have said so much in former articles that further dilation upon the topic is unnecessary. Referring to our former remarks all who desire information on this topic, we will proceed with the description of the sewer before us*.

It consists, as will be seen by the accompanying sectional view, of a metallic box or chamber attached at some suitable point along the line of waste-pipe (generally in the cellar.) The house end of the trap (*A*), which is the portion to be kept free of gas, is closed by a flap-valve *B*, hinged above. This is ordinarily kept tightly closed against its seat by the water seal (*C*), but opens with the pressure of a flow from the house, which it permits to pass into the trap. Another flap-valve (*D*) shown at the other end of the trap, opens outward, and permits the flow from the house to pass out into the waste-pipe (*E*). This vale *D* is hinged against a fixed partition (*F*) extending entirely across the box. The valve (*D*) closes by its own weight after allowing a flow to pass, and any back pressure from the sewer brought to bear upon it, whether by flood or tide, or gas, will only serve the purpose of holding it more firmly against its seat. The trap will thus be seen to have two valves in connection with a water-seal, which act automatically to prevent the contents that has once passed it, or the gases of the sewer, from finding their way back again. To prevent the displacement of the water-seal by siphonage, which may be threatened by any cause that will suddenly empty pipe *E* on the sewer side, a hinged seal (*G*) is provided, which, moving forward with the water as it is drawn out, permits the air to pass out under seal (*F*), and thus equalizes the pressure, when the swing-seal returns to its place it will be seen that an additional fixed-seal *H*, corresponding to *F*, is provided on the house side of the trap. This, although appearing to be an unnecessary precaution, in view of the safeguards already provided, is designed possibly to make assurance doubly sure. The top of the trap is made removable, so that it may be unscrewed and the trap examined, should this be deemed desirable.

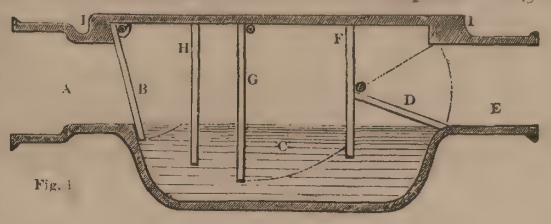


Fig. 1

The apparatus appears to us to possess certain very positive merits, the trapping devices being direct acting; the perfection of the seal and the amount of back pressure they are able to withstand will be gauged by the accuracy of construction and the strength of the joints, both of which elements should offer no serious obstacle in the way of making the apparatus a practically secure trap. W.

*Made by W. Kirk & Co., 1611 Catherine St., Phila.

IMPROVEMENT IN SAW-GUMMERS.*

"*A* represents the bed frame, which is to be secured to a bench or other suitable support. On the bed frame *A* is a longitudinal sliding frame, *B*, moved back and forth by means of a crank-screw, *C*. In suitable bearings on the frame *B* is a cross-shaft, *D*, near the front end, the shaft having at one end the driving-pulley *E* for attachment to the power by belt or otherwise, as desired. In the center of the shaft *D* is a gear-wheel, *a*, and the other end of the shaft projects a suitable distance beyond the machine to receive a burr. The other burr is placed above and forward of this burr on the projecting end of another shaft, *D'*, which is placed in bearings on an adjustably-inclined frame, *G*. The rear end of the frame *G* is held to the frame *B* by

Fig. 1.

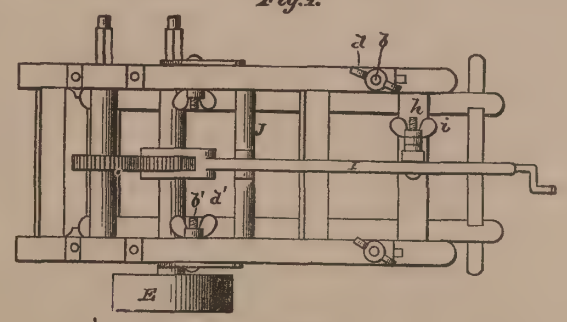
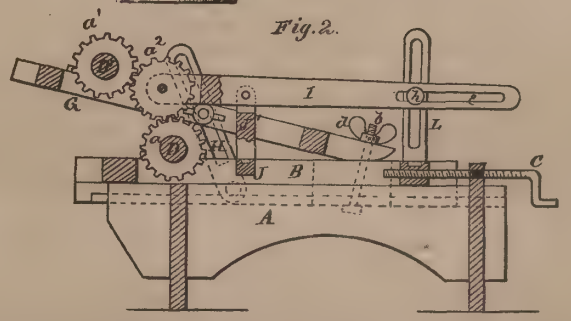


Fig. 2.



means of bolts *b* and thumb-nuts *d*, as shown in Fig. 2, and the frame *G* held at any angle desired by means of bolt *b'* and thumb-nuts *d'*, holding it any height in longitudinally-slotted standards *H* pivoted to the frame *B*. On the shaft *D'* is a cog-wheel, *a'*, corresponding with the cog-wheel *a* on the shaft *D*. The two cog-wheels *a a'* are geared together by means of an intermediate idle cog-wheel, *a²*, mounted in the end of a lever, *I*, which is pivoted in the arm, *J'*, projecting upward from a rock-shaft, *J*, having its bearings in the sides of the adjustable frame *B*. The other end of the lever *I* has a longitudinal slot, *e*, and is adjusted back and forth, and up and down to a vertically slotted standard, *L*, on the rear end of the frame *B* by means of a bolt, *h*, and thumb-nut *i*, so that the cog-wheel *a²* can be adjusted to gear with both the wheels *a* and *a'* at whatever angle the frame *G* may be set. By this construction of the machine, it may be adjusted to suit any distance of the saw-teeth, and it is moved to and from the saw by the crank-screw *C*. It is a power gummer, and cuts two teeth at the same time."

*Patented May 8, 1877, by Richard M. Leftwitch and John W. Crossley, of Lithonia, Ga.

VARIOUS METHODS OF TANNING.

Chemistry has done but little for the art of tanning, but the tanners themselves have made great efforts to diminish the long and tedious operations a skin is obliged to go through before leather, so-called, is obtained. If the tanners had been possessed of a theoretical education combined with their practical experience, the result would have been more satisfactory than it now is. The various attempts made for the advancement of this science, have been done, either by chemists, knowing but few of the elements that constitute good leather, or by practical men ignorant of the action of tannic acid upon the skins.

I do not wish to convey to the reader that things are now as they once were, for surely this is not the case, as considerable time has been gained over the old process of manufacture.

In the following I will give the most important of the various attempts made from time to time, up to the present day, some of which are good and others objectionable:

In 1765, a Society of Arts and Sciences offered a premium to discover a method of tanning with oak saw dust. About the same year the Spaniards brought the dividivi (see REVIEW) to Europe.

In 1768, R. G. Levosier suggested oak leaves; Deyer* was the first to discover and explain the real principles of tanning, his idea was afterwards developed and put into practice by Seguin, (the confidential friend of Levosier) who discovered the gallic acid in the tannin and the property the latter possesses of combining with animal matter albumen and gelatine.

Before the French Revolution it was thought impossible to obtain sole-leather under two years, during this period the chemists Guinton and Moreau set to work and manufactured the same in 8 months, with the assistance of alum.

Seguin proposed the swelling of hides with sulpuric acid; this was done by placing the skins in a weak solution of this chemical for 48 hours, then in a series of vats containing tan and water of different strengths until the tanning was finished.

In 1804, a patent was given in London for tanning with oak bark, which was founded on Seguin's principles; it consists in boiling the bark with water for 4 hours, and then making it flow in vats to cool, in which the skins were placed (the skins were not thoroughly tanned by this process).

In 1814, Gettiffe made an application of this idea; it consisted in having a building two stories high, the lower containing the vats and boilers and the upper the bath tubs. (This was a poor application of a poor process).

In 1823, Spilsbury gave a very quick method, it consists in placing the hides on a wooden frame, on the top of which was placed an empty frame; on this, a frame and hide &c., the whole being screwed together with bolts; between each skin there exists an open space, the tanning liquor is introduced through the upper portion, the air making its escape through an opening, which is closed when the sack is full. The pressure of the liquid forces it through the pores of the skin; when this operation is finished the whole is unmounted and the portions having been in contact with the frame are cut off.

In 1829, Nachette proposed to substitute grape stalks and skins, for oak bark in tanning. This idea does for a country where grapes are grown in large quanties and no trees to be found, (but even the idea, in this country would be foolish.

In 1833, Leprieur published his process. It greatly resembles the one practised by all tanners up to the present day. In consists in having a series of tan infusions (contained in vats) each of which are of a different strength. The skins before being tanned are softened in water, &c.; afterwards placed in a bath of sugar of lead. The inventor believes that the lead salt gives freedom from looseness of texture which they would not otherwise possess. (If these qualities really existed the tanners of the present day would probably make use of this salt, but such is not the case).

In 1837, Harapath, of Bristol, proposed an idea which I think was most excellent, it consists in sewing the skins one on the end of the other, they are then placed in a tan-pit, having a roller near the edge, through this the skins pass before entering the next pit, that contains a solution of ooze of a different strength. Mr. Harapath contended (with reason) that when skins were taken from one pit to another, the ooze existing in the pores was not entirely replaced by the new solution. These rollers get rid of this obstruction. The work by this method is very rapid, six to eight weeks being sufficient; the only objection is, leathers obtained (by this or any other quick tanning process) are brittle and hard.

In 1841 Robert Warrington invented a method of tanning all kinds of hides or skins; for the unhairing he made use of carbonate of potash or soda, dissolved in water, for swelling &c., he made use of other chemicals, such as muriatic acid, oxalic acid &c.; he mentions great advantages in the employ of vegetable matters, rhubarb, apple marc &c. In the same year Orgeau proposed and practiced a method which met with great success in France. The tanners awarded him a gold medal, for the advancement in the art of tanning. His leather has a great reputation on the French market. His tan-pits have a double bottom; the skins are prepared as usual (see REVIEW) and are placed layer upon layer, between each there exists a certain quantity of tan, when three-quarters full a certain quantity of pure water is poured in, the liquid penetrates the mass and passes through the false bottom into a reservoir, from which, by the means of a pump, it is raised up again and thrown upon the surface for the second time (we have here continuous circulation, from the fact that the liquid in contact with the tan becomes saturated with tannin and then coming in contact with the leather deposits the same, filling the pores of skin, and is then ready to absorb a new quantity of tannin and make new deposits, &c.) This operation lasts about one month, at the end of this time the vat is emptied and the skins are placed in the same manner as before in another vat, instead of water a weak ooze is made use of, after repeating this for three times the skins are equal in quality to any old method.

In 1842 Sterlingue profiting by the experience of Orgeau, used many tan-pits which were placed in such a manner that the ooze passes from the bottom of No. 1 to the upper portion of No. 2. Lydner some years later proposed to expedite the tanning; he performs this by pricking, by means of an instrument with a surface of fine needle points, the number of these varies according to the thickness and quality of the skin; the idea of perforating a skin, the object of which is to be water tight, seems absurd, but the inventor says "better leather can be prepared by this method than any other." He also says that he can tan in half the time of any ordinary process. I have no doubt of the truth of the above operations but "seeing is believing."

In 1844, Mr. Turnbull proposed the use of a physical force for the tanning of skins by endosmose and exosmose. He sews the skins together and thus forms bags, into which he places the tan and warm water, they are then hermetically closed and placed in vats containing a purified solution of catechu. The two liquors thus composed have the physical force wished for; during the tanning the density of the liquor in the vats is kept constant by the addition of sugar from time to time. Mr. Turnbull says† "the economy obtained by my process is immense; the tanning by the use of oak bark requires eighteen months, by my method eighteen days are sufficient; as for calf skins that require six to eight months by the usual method, require from two to four days by my process." The results obtained by this method are very satisfactory.

About the same year Squire proposed placing the hides in a horizontal wooden cylinder filled with ooze, with projecting ridges causing agitation of the skins (warm ooze is made use of). There existing no air many difficulties of the ordinary method are gotten rid of; the ooze is soon exhausted and must be rapidly replaced; tanning by this method requires about fourteen days, but the leather obtained has little or no bloom (here again is a bad result obtained by quick tanning, and is a guide to buyers in leather, which enables them, as they imagine, to judge the quality; but this does not necessarily follow, as there are many varieties of good sole leather that have but little bloom.

About the same year Drake, of England, proposed a simple method; it consists of sewing the skins (as in Turnbull's method) and suspending them with cords sewn to their sides, a solution of tannin or ooze is placed in the bag, to prevent bulging; vertical racks were made use of, which caused unequal thickness of the leather obtained; the skins thus become well impregnated with tannic acid and are unsewed and the sides cut off.

Hydrostatic pressure has been used with some success, it consists in forcing the liquor through the hides kept from contact with each other by strong woolen tissues.

In 1849, H. Hibbard patented a process uniting in a high degree the advantages of economy of time and labor. To prepare the skin he made use of quicklime, woodashes, and salt; in a few hours the hair comes off with ease. For tanning sheep, deer or goat skins &c., salt, sulphuric acid, sumac, hydrochloric acid, dried clover and water (the details of this process being patented I am not at liberty to give them in full).

In 1856 Mr. Hatcz, of Princetown, Illinois, invented a process called *Illinois French tanning*. This idea is copied to a certain extent from the Kirguises & Baskirs; it consists in transforming the hides into leather by the use of smoke; this idea is very good in the West where no bark is to be obtained. This same gentleman makes use, with great success, of a sweet-scented clover (Melilotus); this plant should be gathered when in flower or when about going into flower.

In 1860 Mr. Dennis Aldrich,‡ of St. Louis, Mo., invented an apparatus which many think a great improvement. This method consists in having an apparatus composed of a series of air tight vessels, with air pumps, and system of connection; the use of air tight vats for liming avoids chemical changes in the liquor and prevents ammoniacal gases making their escape (this greatly resembles Squire's method).

In 1863, V. E. Rusco, of Chicago, invented an apparatus considered good and used by many tanners of this country; it consists in having one or many wheels, containing hooks in their interior by the means of which the leather is kept in motion; the velocity given is two revolutions per minute. When the hides are ready for the liquor they are placed in the wheel by openings, which are immediately closed. The strength of the liquor in each wheel is different, and kept cool, never in excess of 80°F.

Liming can also be done in a wheel of this description (here again is Squire's idea).

Darcet suggested that mineral substances should take the place of vegetable, his principal chemical being a sesqui-oxide of iron, which combines with the gelatine, giving a preciptate similar to what is obtained by the use of tannin; the skins are left in this iron solution for a time that varies with the thickness of the leather, that is to say from three to six days.

Bordier suggested a method where 200 lbs. of burnt copperas are dissolved in 19 gallons of water and mixed with 44 lbs. of sulphuric acid, then agitated with 44 lbs. of black binoxide of manganese; this operation lasts about six to eight days for thick skins and three to four for thin. The leather obtained by all methods making use of mineral substances breaks more easily than when the tanning is done with vegetable materials.

We can conclude from the above that the great problem of tanning is to make the best leather in the shortest possible time, and using the least possible tannin.

Some few, but very few attempts have been made to get rid of bathing (it is astonishing that more advancement has not been made in this direction, when this *disgusting* method is taken into consideration. In London alone $50,000 are yearly spent for collecting the manure on the streets).

Turnbull suggested a method impossible to make use of; it consists in forming a saccharate of lime soluble. Bolgan's idea was based on the property sulphide of calcium (see REVIEW) has of acting on the hair; a certain quantity of the chemical is placed on the hairy portions of the skin; on another skin a new quantity of calcium is poured on. These skins are placed hair against hair, and are pressed against each other by means of weights, after two hours the hair comes off without difficulty; it was suggested that lime should not be made use of, but a more soluble alkali should take its place. Crystals of carbonate of soda in the following proportions: 2000 lbs. of skins, 40 lbs. of soda, 30 lbs. of slacked lime with 120 gallons of water; an unsoluble carbonate of lime will form, and the alkali becomes caustic; this operation lasts some three days, and is much practiced by tanners in Europe.

From all that has been said on this subject we can only conclude that very little progress has been made in the art of tanning, and we must again look to our chemists for still greater advancement in this science.

LEWIS S. WARE, C. E.

*I know of no author who even mentions Deyer's name; this without doubt is great injustice.
†Comptes Rendus Acid des Sciences, January 12, 1846.
‡A full description of the above apparatus is given in the work of Frk. Dussauce.

CARBOLIC ACID AND OTHER DISINFECTANTS.

Carbolic acid (or phenol), a compound obtained in the fractional distillation of coal-tar, is, beyond question, the most valuable hygienic disinfectant known up to the present time. When quite pure it appears in the form of colorless crystals, that dissolve in about twenty-five times their bulk of water, and in all proportions of alcohol, ether, or glycerine. The ordinary commercial (liquid) carbolic acid is a mixture of carbolic and cresylic acids, various neutral hydro-carbons, &c. This substance possesses certain very remarkable and valuable properties. Even in very trifling quantities it acts as a powerful antiseptic, arresting the processes of fermentation and putrefaction, and acting as a violent poison to the lower forms of life. The antiseptic virtues of carbolic acid are derived from its power to coagulate soluble albuminous substances, (the carriers of organic life, and therefore the ultimate causes of putrefaction), a property that it possesses perhaps to more marked and positive degree than the metallic salts, which were discussed in this connection in a previous article.

In addition to this antiseptic property, which carbolic acid possesses in an exalted degree, it shares with the chloride of lime the valuable endowment of being volatile, in virtue of which it is enabled to exert its purifying influence upon an infected atmosphere. For the reasons named, it stands thus far without a rival as a hygienic agent, and although it has only lately become generally known, enormous quantities of it are at present annually consumed, and with the most beneficial results. It will arrest fermentation; added to writing ink it will prevent its moulding, while flour paste and similar mixtures may be kept for an unlimited period without souring; applied as a dressing to wounds, sores, ulcerations, and the like, it prevents the parts from becoming offensive and notably assists the healing process, and for these uses it has already become an indispensible agent in medicine and surgery. For the purification of an infected atmosphere it excels even the chloride of lime in the rapidity of its action; while for cleansing the walls, floor and furniture of hospitals, &c., it can be applied with lime or water with greater convenience. Applied to accumulations of fecal and other offensive refuse, a small quantity of carbolic acid will produce a marked hygienic benefit, although, as with the chloride of lime, this mode of employing it is unfavorable to the bringing out of its best results. Cesspool accumulations, as we have taken occasion to point out before, should be regularly treated with a deodorizer (like the sulphate of iron) to check the liberation of the pungent ammoniac compounds, openings should be kept tightly closed, and the contents removed frequently; while hygienic disinfection of the surrounding atmosphere can be insured either by strewing the floor or ground occasionally with acidified chloride of lime, or with saw-dust or other inert powder moistened with carbolic acid, and applying at intervals to walls, floors, wood-work, &c., a wash of weak carbolic acid. Disinfecting devices employing carbolic acid have lately grown into great favor, as applied to water-closets, urinals and the like, for which purposes, as must appear from what has already been said about it, its employment cannot fail to be both of hygienic value as a neutralizer of the insidious dangers of escaping sewer gas, (from which few of such convenient contrivances are altogether free), and serviceable as a deodorizer. In this connection it may be well to add, that much of the commercial carbolic acid used for such purposes is very impure; some brands especially possessing an odor very penetrating and, to many persons, unendurable; although, to the majority of people, it is not disagreeable. Should it be considered objectionable, however, the odor of the carbolic acid may be quite effectively masked by the employment, in connection with it, of a solution of camphor in alcohol.

Salicylic acid, benzoic acid, and a number of analogous organic compounds are worthy of notice in this place, since they are sometimes spoken of as disinfectants. These substances possess antiseptic qualities in an exalted degree, and as preventives of putrefaction, decomposition and fermentation, which are the vehicles for the dissemination of contagion they are invaluable, but for disinfecting purposes in general they are not qualified.

Hyponitric acid and ozone (the first produced by the action of nitric acid on certain metals in contact with the air, and the latter by passing electrical sparks through the air) are both gaseous bodies and powerful oxidizing agents, and should properly have been treated of in former articles.

Hyponitric acid acts destructively upon organic (organized or unorganized) matter of every kind, and as a hygienic disinfectant is entitled to rank very high.

A commission of the French academy, appointed to investigate the merits of various disinfectants, gave a very favorable account of the value of this compound as a hygienic agent for the disinfection of an infected atmosphere by the destruction of the infectious germs. This committee employed in its trials diluted nitric acid and copper turnings, the mixture being made in earthen jar, the doors and windows of the apartment to be fumigated being carefully closed. The proportions of materials to be used for the purification of an apartment 40—50 cubic yards capacity, are recommended to be as follows: water, 2 qts., commercial nitric acid, 3½ pounds, and copper turnings, ½ pound. The time required for the purification of an apartment of above dimensions is stated to be 48 hours. Of the nature of ozone but little is known, save that it is an energetic oxidizing agent; and opinion is divided on the question of its hygienic properties, some authorities holding that it is a valuable hygienic agent, while others contend that it is the source of many of the ills that flesh is heir to.

Sulphurous acid, which is often employed for the fumigation of infected localities, and which is generated by burning sulphur in a confined apartment, can scarcely be said to possess disinfecting virtues of its own. The burning sulphur probably acts by gradually consuming the free oxygen of the air, and thus destroying the disease germs contained in it.

In the several articles on the subject of disinfection that have made up this series of contributions, the origin and spread of infection were stated to be referable to the multitude of organized germs, which find in dead organic matter the proper soil for their development, and from which, or from the bodies of persons or animals suffering from disease, they are again given off to the air in prodigious numbers and widely disseminated. From this view of the case, which has been found to be the proper one, it is obvious that a perfect disinfectant must be one which will not only check the process of putrefaction or decay, but which will also exercise a purifying influence upon the polluted atmosphere by the destruction of the disease germs with which it is charged. For this purpose it is obvious that such a disinfectant must be of volatile nature. The suppression of an offensive smell, which, in the opinion of many people, is the essential thing to accomplish, may, as we learned, exercise little or no disinfecting action, and though very useful and even necessary for comfort, may leave the atmosphere as rank with the obscure elements of contagion as before. W.

EFFECTS OF PUNCHING UPON THE TENACITY OF STEEL PLATES.

Punching is supposed to lessen the tenacity of steel. Read's work on iron and steel ship-building records numerous experiments made in England, and from them recommends the almost exclusive use of drilling steel plates, &c., indicating, however, annealing and the use of dies of greater diameter than the punch, as modes of lessening the evils of punching.

We give herewith facts based upon the experiments at L'Orient, recorded by Barba.

The tensile tests of Bessemer steel from Terre Noire, showed that the width of the strip has had a great deal to do with the tenacity; giving the following results with plates .27″ thick; the test pieces being punched in the middle, the hole being .66″, and the die being for some .76″, and for others .82″. In the first case the holes were cylindrical; in the second, conical.

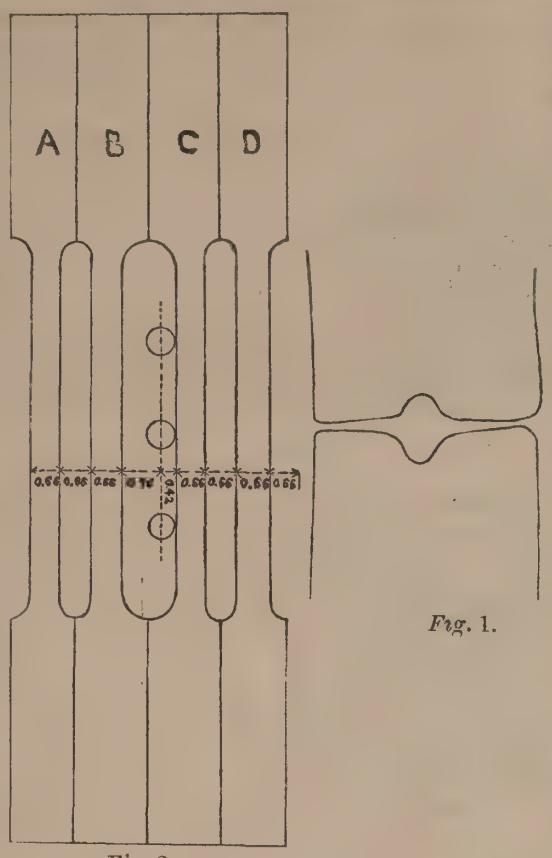


Fig. 2.

Fig. 1.

Width of Specimens.	Resistance to Rupture, per Square Inch.			
	Cylindrical Punching.		Conical Punching.	
	With fibers.	Across fibers.	With fibers.	Across fibers.
In.	Tons.	Tons.	Tons.	Tons.
1.24	27	26.96	31.73	32.17
1.95	25.89	26.33	28.23	27.47
2.65	25.25	23.54	26.27	24.23
3.35	22.65	23.54	22.31	24.23
4.05	24.23	23.54	22.91	24.23
4.75	23.09	23.54	23.73	24.23

This table shows the resistance to be the same, with or across the fibers, and is confirmed by numerous other tests made at the same works. Stretching, also, is the same in both cases; hence we will hereafter make no reference to direction, though all the trial strips here mentioned were tested lengthwise of the plate.

Punching seems to make a decided alteration; reducing the resistance in the widest strip 30 per cent.; and untempered Bessemer plates gave a resistance of 32.81 tons per square inch.

We may note (1st) that tenacity diminishes in both varieties of punching, as the strips increase in width; (2d) that conical punching does not greatly effect the narrow strips, while cylindrical punching does most markedly; and (3d) the effect of both modes of punching is the same on wider strips.

Now if it were punching that affected the tenacity, the narrowest specimens ought to resist the least. The results may be attributed to alteration in elasticity; especially as in the wide specimens the form of fracture (Fig. 1) proves that the central fibers stretched less than the others, and ruptured first. To note whether the elasticity of the fibers around the hole was affected, and if so, how far, from series of strips were traced upon a Bessemer plate, as shown in Fig 2. Between two series were punched cylindrical holes (.66″ punch, .70″ die); between two others, conical holes (.66″ punch, .80″ die), and about as far apart as needed for a water-tight joint. In each series there were cut four test strips parallel to the holes, and at different distances therefrom.

Marks	Resistance to rupture per sq. in. of original section.		Per cent. line of stretching.	
	Cylindrical	Conical.	Cylindrical.	Conical.
	Tons.	Tons.	Tons.	Tons.
A	31.54	30.57	21.5	19.
	31.48	31.89	21.5	22.
B	30.70	31.02	22.0	21.5
	30.89	30.89	20.0	22.
C	30.70	30.70	22.0	21.
	30.70	30.89	20.0	21.
D	31.32	31.16	20.0	20.
	30.89	31.73	20.0	20.5

The table shows that neither stretching nor tenacity was altered in the parts subjected to stress. As, however, an alteration in elasticity, in a region concentric with each hole and reaching but slightly into *B* and *C*, might not have been noticeably perceptible, new specimens were cut from the same plate, cutting them on the edge with a square punch, then filing off .058″ to .078″ on each side to make the edges straight. These strips gave a mean resistance of 30.45 tons, and a mean stretching of 21.2 per cent. This showed that any alteration in elasticity is felt sensibly only in the region about .058″ wide surrounding the punch holes.

In subsequent articles we shall discuss the effects of punching and drilling upon the bending of plates. G.

IMPROVEMENT IN TRAVERSE-MOTIONS FOR GUIDE-WIRES OF SPINNING-MACHINES.*

The invention consists of the wire-board traverse connected to the spider-shafts independently of the ring-rail, whereby its traverse can be regulated at will, by which a more equal friction on the yarn can be maintained to make the twist more even, th labor less, and the wear on the rings less.

Fig. 1

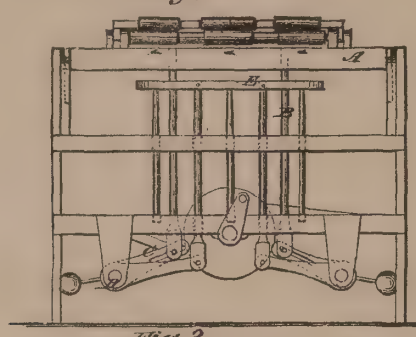
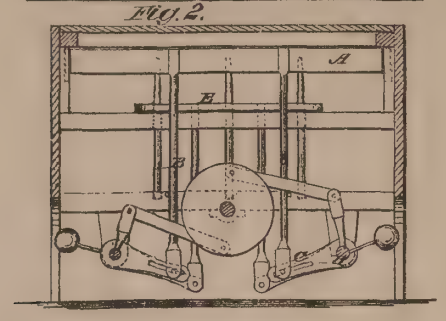


Fig. 2.

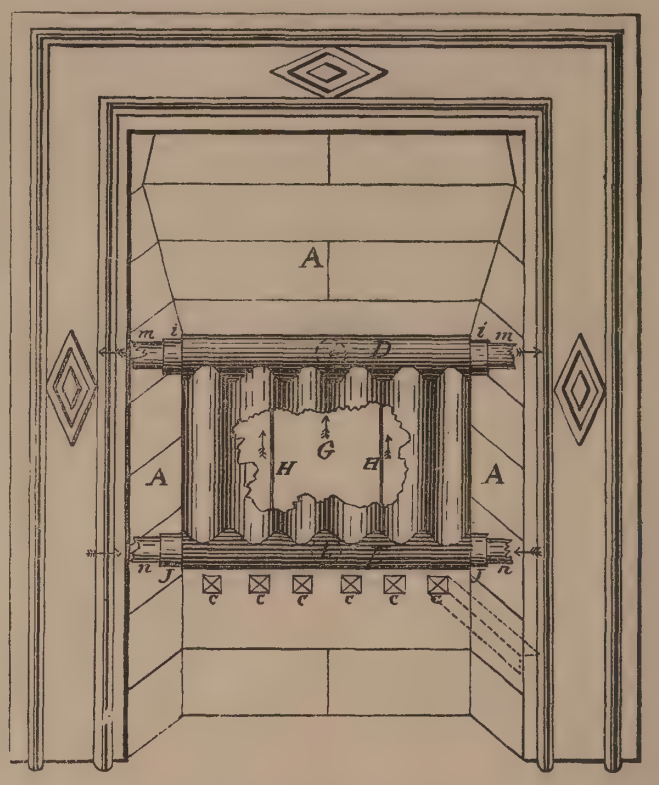


A is the wire traverse-board, mounted on the vertically-movable rods *B*, which are connected at their lower ends with the arms *C* of the spider-shaft *D*, instead of to the ring-rail, as heretofore, whereby its traverse may be varied at will relatively to the traverse of the ring-rail, in such a manner that the tension and friction on the yarn can be equalized. The rods *B* are connected to the arms in slots in the latter, whereby the traverse can be varied."

*Patented March 6, 1877, by Joseph Garrett, of Chester, Pa.

WATER-BACK FOR FIRE-PLACES.*

This invention is intended to be built at the back of a fire-place, and there serve as a water heater, The water-back is constructed of iron of a plain surface back, but corrugated on the side facing the fire in order to present a large heating surface. Circulation of the hot and cold water is constantly kept upby means of the pipes *m* and *n* at the top and bottom of the heater, and by means of the pipes *LL* entering at the



back. The arrows indicate the direction of the flow. The apparatus is divided into three compartments by means of the partitions *HH*—each compartment having consequently its own admission and discharge pipe. The grate-bars are to be nearly level with the bottom of the water-back, and the burning coals lie against its corrugated surface.

*Patented by George W. Moore, Lynchburg, Pa.

[Copyrighted.]

SLIDE VALVE GEARS.

By Hugo Bilgram, M. E.

Part III.

The Meyer Cut-Off Gear.

The valves of this gear are substantially of the type represented in Fig. 58 and are moved by two separate eccentrics, located on the shaft as indicated in Fig. 59. The cut-off valve, however, differs somewhat, in being made of two parts (see Fig. 65) that are attached to the valve-stem by means of a right

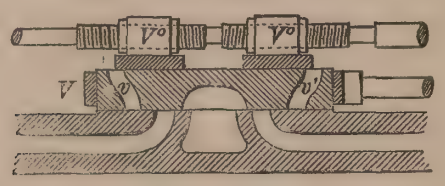


Fig. 65.

and a left-handed thread. The valve stem is joined to the eccentric rod by a swivel, and can be rotated by a hand wheel or other suitable mechanism, whereby the distance of both cut-off plates can be adjusted, even while the engine is running. The lap of this valve can thus be changed at will.

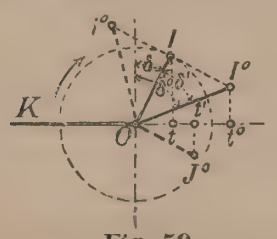


Fig. 59.

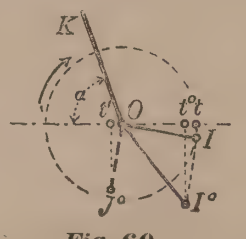


Fig. 60.

For converting the diagram of eccentrics (Fig. 59) into the valve diagram (Fig. 66) beginners are advised to make use of tracing paper to locate the points Q and Q' relating to the main eccentric I, and $Q°$ and Q'' relating to ideal eccentric $J°$. The relation existing between the diagrams Fig. 66 and Fig. 59 involves the following inferences. The distance $OQ°$ is equal to one-half the *relative* travel, and the distance $Q'Q°$ equals one-half the *absolute* travel of the cut-off valve; and, if we draw the horizontal line h through the point Q', the angle $hQ'Q°$ and $OQ'Q°$ will equal the angles $\delta°$ and δ' of Fig. 59, respectively, these angles appearing, in the valve diagram, in a direction opposite to that in the diagram of eccentrics. *The line $Q'Q°$ represents manifestly the cut-off eccentric in the same sense as the line OQ represents the main eccentric.*

By sweeping the proper lap circles from the points Q and Q', the diagram for the main valve can be completed, and that of the cut-off valve can be drawn to suit the lap of the cut-off valve for the time being. Assuming, at first, a permanent negative lap, we draw the lap circles $L°$, as shown, and find the passage v (Fig. 65) to be opened while the crank moves from $A°$ to $E°$, but as the main valve opens the port of the cylinder only after the crank passes the line A, the admission of steam will take place between A and $E°$. The passage v, of the main valve will remain open between A'' and E'', and hence the steam will be admitted, at the return stroke from A' to E''.

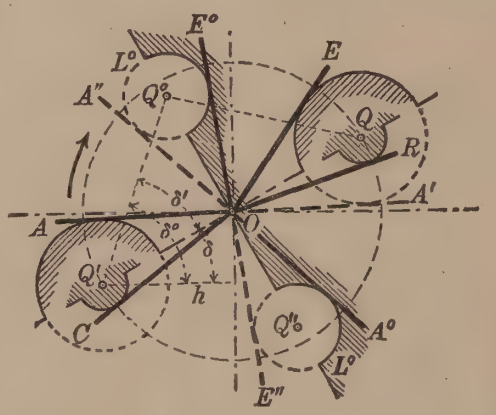


Fig. 66.

A change of the lap of the cut-off valve requires the drawing of other lap circles from the point $Q°$, and the diagram will appear as shown in Fig. 67, where four grades of expansion are represented, two with positive and two with negative lap. The lower mate of $Q°$ is omitted, being of little interest since this diagram shows the action on but one side of the piston.

A glance at this figure now shows that the range of expansion includes all desirable grades, provided the cut-off valve admits of sufficient adjustment; and also the sharpness of the cutting off shows a fair figure. The latter is greatest when the lap equals zero, and becomes less as the lap is either increased or reduced from this point.

However, the margin of adjustment of the cut-off valve is practically limited, as will be shown in the following problem, and this fact puts a limit either to the range of expansion or to the rapidity of the cutting off; the latter case involves a reduction of the relative travel of the cut-off valve, or, in other words, a reduction of the distance of the cut-off eccentric $I°$ (Fig. 59) from the main eccentric I.

In order that the rapidity of the cutting off should suffer the least reduction at the change of grades, it is best to so locate the cut-off eccentric that this rapidity is equal at the two extremest grades, and this is accomplished if the positive lap of the earliest cut-off equals the negative lap of the latest cut off desired. Therefore, if it should be required to make the cut-off adjustable between the crank-angles A and E, (Fig. 67) the lap-circle $l°$ would stand for both extreme grades, and this circle can be tangential to both the lines OA and OE only, if the line $OQ°$ is at right angles with OQ, and this condition requires the line $II°$ (Fig. 59) to form right angles with the line OI. Such a full range of expansion is, however, not always required, and hence this rule is not a definite one.

The question may be raised if this gear will ever admit the steam twice during one stroke, *i. e.*, if the cut-off valve will ever re-open before the main valve closes the steam port. Such an event would be indicated by the diagram if the rotating crank line would meet the line $OA°$ (Fig. 66) before passing the line OE, and this state can only exist if both the negative lap of the cut-off valve and the angle of advance of the cut-off eccentric are excessive, and can, therefore, be avoided.

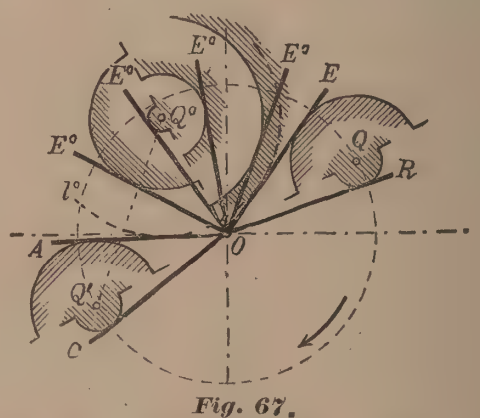


Fig. 67.

This valve gear is susceptible of quite a number of modifications. The duty of cutting off may be imposed upon the inside edges of the cut-off plates, by their being farther apart while the upper terminals of the steam passages of the main valve are closer together. The difference between this arrangement and the one considered before consists in that the relative movement should be exactly the opposite to produce the same result. We should here remember that the diagram furnishes only the angular position of the eccentric, leaving a choice between two diametrically opposite points, between which the decision is to be made, as explained in a preceding chapter. The same question is now at issue in relation to the ideal eccentric of the relative movement of the cut-off valve, which, in this instance, is found to require a position diametrically opposite to the point $J°$, Fig. 59, and the real eccentric should consequently be at $i°$.

The same conclusion may be reached in a somewhat different way. If we consider that the points Q and $Q°$, that were obtained directly from the inverted tracing, always mark the passage of the valve from *positive to negative* movement, it will be understood why the lap circles drawn from those points as centres always marked the closure of the admission at the fore-stroke. But in the last case the cut-off is effected by a *positive* movement, and if a result identical to that represented by Fig. 66 is desired, the point $Q°$ should represent the passage from *negative to positive* movement, and hence its mate, Q'', is the point that should be obtained from the tracing, and it is the line $Q'Q''$, instead of $Q'Q°$, that now represents the real cut-off eccentric. Of course, the line $QQ°$ can be substituted for $Q'Q''$, both lines being equal and parallel.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Mars's Moons and the Nebular Hypothesis.—Mr. C. B. Waring, of Croton on the Hudson, has written to the *Tribune*, suggesting the rapid motion of one of the newly discovered moons of Mars may be explained without impugning the nebular hypothesis, by the supposition that there is a resisting medium in space. If at the time this moon was left behind by the shrinking nebula of Mars, its distance from the centre of that nebula was comparable with that of our moon from the earth, and it was afterward drawn nearer to the planet because of the check occasioned by a resisting medium, its time of revolution would be shortened as it approached the planet. On the other hand, the revolution of the planet itself would be little affected by the resisting medium; but to whatever degree it was affected, its speed of rotation would be decreased, and hence the difference between the times of the planet's rotation and the satellite's revolution would become greater. Mr. Waring regards the discovery of the swift-moving satellite as strong evidence of the presence of a resisting medium in space. He suggests as problems not less difficult of solution, the questions why the eighth satellite of Saturn is 12° or 14° out of the plane of the other satellites and the rings of that planet; and why our moon is 18½° nearer the ecliptic than the plane of the earth's equator.—*N. Y. Tribune.*

A New Falsification of Sulphate of Quinia.—Dr. Jaillard has discovered a new and altogether extraordinary sophistication of quinia sulphate, which occurs in the French market, and bears the labels of Pelletier, Deldondre and Levaillant, so well imitated as to be undistinguishable from the genuine. The contents of the bottles present the usual appearance of quinia sulphate, but the chemical behavior is entirely different. The salt is soluble in water, gives only a small precipitate of barium chloride, and strikes a purple color with ferric salts. It contains sufficient quinia to give the thalleioquin reaction and to show florescence. The adulterant is supposed to be potassium salicylate, crystallized from alcohol to give it the silky appearance of quinia sulphate.—*Jour. de Pharm. d'Anv*, 1877, 207, *per New Remedies*, vi, 303.

Siemens' Compressed Glass.—In the factory of M. Siemens, in Dresden, a glass is made which possesses, so we are informed, all the properties of the tempered glass of M. La Bastie. The strength of this glass is obtained by compression in metallic cylinders, and the process admits of larger sheets being made than by the La Bastie. The glass has a beautiful appearance, and can be far more easily ornamented than the ordinary glass. M. Siemens claims that his glass is stronger than tempered glass in the proportion of 5 to 3, and from 7 to 10 times the strength of ordinary glass. The fracture is fibrous, while that of the La Bastie is crystaline. In the experiments made before the Polytechnic Society of Berlin, a leaden ball of 120 grains was let fall upon a horizontal sheet of glass supported only at its four corners. Ordinary glass broke by the ball falling from a height of 30 centimetres; while the compressed required 3 metres and then only fractured after several shocks.—*Moniteur Ind. Belge*, iv, 431.

The Bleaching of Sponges.—(Pharm. Centralhalle, 1875, 333, from Zeitchr. des Oesterr. Apoth. Ver.) As the bleaching of sponges by means of sulphurous acid or chlorine is injurious to the health of the operator, the writer recommends a process in which no noxious gases of any kind are evolved.

The sponges are first soaked in hydrochloric acid to remove the lime, then washed with water, and immersed in a two per cent. solution of potassium permanganate. When taken out they appear brown, from the despotism of manganese oxide, which must now be removed by steeping them about two minutes in a two per cent. solution of oxalic acid, to which a little sulphuric acid has been added. As soon as the sponges appear white, they are well washed out with water, to remove the acid. Strongly diluted sulphuric acid may be used in place of the oxalic acid.—*Zeitschr. des Oesterr. Apoth. Ver. per The Pharmacist*, x, 316.

Magnetism of Nickel and Copper.—Mr. Hall affirms in the *Moniteur Scientifique* that with feeble currents the magnetic power of nickel is equal to that of soft iron, but with stronger contents it is comparatively futile. Under any circumstances, however, the magnetic power of cobalt is much inferior to that of the other two metals.

The Eucalyptus Globules planted in Jamaica some six years ago, have acclimatized themselves so thoroughly on the plateaus of this island that many have attained a height of 60 feet, with a trunk of 1 ft. diameter near the earth. They do not prosper in the low lands of the island.—*La Nature*, v, 237.

For the Water-Proofing of Smooth and Light Material for umbrellas, etc., the following process is recommended: 1 part of paraffin to 10 or 15 parts of benzol, or a piece of a paraffin candle, say one inch in length, scraped and placed in a glass with ¼ lb. of benzol. On slight agitation the whole mass will form a perfect solution at once, and is to be used as a coating for the material to be proofed. The color, softness and durability of the material is not impaired by the treatment. It is specially recommended for gentlemen's umbrellas. The only objection is the combustibility of the compound. *D. All. Polytech. Ztg*, v, 438.

The Removal of Tin from Copper Vessels coated therewith can be easily accomplished, according to Prof. Bottger, by immersing the vessel in a concentrated solution of sesqui chloride of lime. In a very few moments the tin is removed from the copper, and nothing remains to be done but scour the latter with moistened sand and dilute hydrochloric acid to obtain a perfectly clean surface.—*D. Ind Ztg. per Bay. Ind. and Gew. Blast*, 1877. 270.

ENGINEERING—CIVIL AND MECHANICAL, &c.

Progress of the New Pacific Railways.—There is considerable significance in the fact that, notwithstanding the antagonism to new railway lines intended to traverse thinly inhabited districts, work is now, or has recently been, actively progressing on three of the railways intended to connect the Pacific coast with the middle and eastern portions of this continent.

The work of track laying on an important branch or division of the Canada Pacific was commenced in Manitoba on the 29th ult., amid imposing ceremonies, in which Governor-General Dufferin and his wife, and a number of officials participated Rolling stock, intended for construction service, has also been forwarded to that region. While our northern neighbors may consume years in the task of completing an iron link between Canada and British Columbia, they are evidently determined to finish some very important sections of that great enterprise.

The Northern Pacific has recenty completed a section of its line stretching eastward from the Pacific coast, and it is actively engaged in preparationa for a western extension of its existing lines in Dakota.

Meanwhile the Southern Pacific has advanced eastward to Yuma, where it has encountered an obstacle in the refusal of the United States commandant to permit the line to cross a United States reservation without the consent of Congress. Even enthusiastic projectors ought to respect the formalities required in this instance, and the motives for haste must be strong, indeed, that have led to the adoption of the extaordinary course of building a line in advance of the procurement of the necessary legal authority.

Whatever may be thought of this unusual proceeding, the fact remains that even during an era of unparalleled depression the work of creating new links between the Atlantic and Pacific coasts, in three different lattitudes, has been prosecuted with considerable energy.—*Railway World*, iii, 962.

How to Distinguish Steel from Iron Tools.—It is impossible to distinguish between iron and steel tools; they have the same polish, the same workmanship; use will commonly alone show the difference. To make this distinction quickly, place the tool upon a stone and drop upon it some dilute nitric acid (four parts of water to one of acid). If the tool remains clean, it is of iron; while if of steel it will show a black spot where touched by the acid: these spots can easily be rubbed off.—*Moniteur Ind. Belge*, iv, 434.

Drinker on Tunneling.—The engineering profession will be gratified to learn that this long expected contribution to the literature of this important branch of engineering science will shortly appear, through the publishing house of John Wiley & Sons, N. York.

—The Louisville Bridge and Iron Company, of Louisville, Kentucky, are running on full time and employing about 400 men, 225 of whom are engaged in the shops of the company, and 175 in erecting structures in different parts of the country. They have the contract for the Cincinnati Southern Railway bridge, over the Tennessee river, about six miles above Chattanooga, which is to be a wrought iron structure consisting of six spans of 210 feet each, one draw of 280 feet, and one span of 260 feet, and is to be completed January 1st, 1878. They also have have contracts for bridges on the Louisville, Nashville and Great Southern Railway, Mississippi and Tennessee Railroad, and Natchez, Jackson and Columbus Railroad, and also several contracts for highway work. They have just completed, for the Indianapolis Belt Railroad, a double track wrought iron triangular truss bridge, which is the only double track iron bridge in the state of Indiana.—*Railway World*, iii, 968.

Record of New Railway Construction.—The *Railroad Gazette* of Oct. 12th has information of the laying of track on new railroads as follows:

Montclair & Greenwood Lake.—Extended from Cooper, N. J., north by east to State Line, 3 miles.

Cheraw & Chester.—The first track is laid from Chester, S. C., east 5 miles. It is of 3ft. gauge.

Galveston, Brazos & Colorado.—During the present year this road has been extended 5 miles, to a point 12 miles west from Galveston, Texas.

Scioto Valley.—Extended north 15 miles to Waverly, O.

Fond du Lac, Amboy & Peoria.—Extended from Mayville, Wis., southward to Warrior Ridge, 15 miles. It is of 3 ft. gauge.

Rock Island & Mercer County.—Extended southward 9 miles to Cable, Ill.

Burlington, Cedar Rapids & Northern.—The *Pacific Division* is extended from Grundy Centre, Ia., to Holland, 3 miles.

Colorado Central.—The extension of the *Georgetown Branch* to Georgetown, Col., is 4 miles longer than previously reported. It is of of 3 ft. gauge. On the extension of the standard-gauge line from Longmont to Hazard track is extended 21 miles, to Fort Collins, Col.

Northern Pacific.—The *Puyallup Branch* is extended 19 miles to the Puyallup Mines, completing the road.

South Pacific Coast.—On the *Alameda Extension* track is laid from Newark, Cal, north to San Lorenzo, 13 miles. It is of 3 ft. gauge.

This is a total of 109 miles of new railroad, making 1,505 miles completed in the United States in 1877, against 1,719 miles reported for the corresponding period in 1876, 861 in 1875, 1,125 in 1874, 2,867 in 1873, and 5,066 in 1872.

Progress of St. Gothard Tunnel.—The advancement made in the St. Gothard tunnel during the week preceding the last, was 29.6 m. at the Goeschenen, and 16.7 m. at the Airolo end—a progress of about 6.6 m. per day. Two days were lost in varifying the axis of the tunnel at the Airolo end—*Monituer Ind. Belge.* Oct. 1.

—The Columbia, Ohio, water works, which are upon the Holly system, have now been in operation about seven years. Since they were built, the city has abandoned the use of their entire force of steam fire engines, and the losses by fire have been decreased from an average previous to the introduction of of water supply, of 65-100 of one per cent. to 9-100 of one per cent. upon the total tax valuation, while since 1870 the valuation of taxable property has increased, in round numbers, from $16,000,000 to $37,000,000 in 1876. The average daily amount of water now being pumped is about 1,600,000 gallons, the machinery with which the works are supplied being capable of furnishing 10,000,000 gallons daily for domestic use or 7,000,000 gallons under fire pressure. There are now in use in the city upwards of 600 improved water meters, from the Eagle Meter Co., of Brooklyn, L. I., which are recommended by the engineer in his report as giving better satisfaction than any meter yet tested. Since their introduction, three years ago, the consumption has but slightly increased, notwithstanding the growth of the city. There are about 45 miles of cast iron pipe laid, in connection with the works, which was furnished by H. R. Smith & Co., of Columbus, to the credit of which establishment it may be said that not a single length has thus far been obliged to be taken up from any faultiness of the pipe.—*Engineering News*, iv, 293.

—The Clinton Bridge Company, of Clinton, Iowa, have now under way in their shops, or in process of erection, 23 combination and 8 iron bridges, aggregating about 3,700 lineal feet. They have just contracted for 300,000 feet of bridge timber in Wisconsin, which they will need to finish up the contracts they now have on hand.

MINING, METALLURGY AND MINERALOGY.

Kraff and Sauve's Method of Steelmaking.—By this method Bessemer, Martin, or other metals, which may be regarded as compound intermediate between the pig iron, iron, and steel, are transformed into fine steel. These substances acquire all the properties of the latter metal by being kept for some hours at a red heat, in a bed of carbon, over which a current of nitrogen, carbonic oxide, and various hydrocarbons passes slowly. Wood, charcoal, turf, coke, or other fuel, thoroughly dried and heated to 50° C., are then immersed in a hydrocarbon, and alternate layers are formed of fuel and bars of metal. The whole is inclosed in a crucible-shaped pot, and heated to a red heat, the excess of oxygen is transformed into carbonic oxide, and the nitrogen into ammonia, so that the metals are placed in the gaseous medium recognized as the fittest for their conversion into fine or cemented steel.—*Eng. and Mining Journal*, xxiv, 291.

New Minerals.—*Uranocircite*, a phosphate of baryta and uranium resembling autunite, for which is was long mistaken, occurs in quartz veins in the granite of Falkenstein, Saxon-Voigtland. *Spæro cobaltite*, occurs in spheroidal forms with roselite at Schneeberg, Saxony, structure coarsely radiated, rhombohedral, in microscopic crystals. Color, peach-red; H=4; sp. gr. 4.02—4.13; blackens on ignition in closed tubes. Dissolves in warm hydrochloric acid with effervescence, compactive carbonate of cobalt.

Szmikit, a New Sulphate of Manganese.—This mineral is amorphous, forms stalactitic aggregates having an uneven fracture. H.=1.5. G.=3 15. Color, a dirty white and a reddish white where newly fractured. If a new surface be exposed for several days to a moist atmosphere, they are turned to an intense red, and an increase in weight is noticeable. Two analyses made of this mineral, the one by Albrecht Schrauf (I) and the other by Dietrich (II) gave the following constitution.

	I	II
Sulphuric acid,	47.43	47.11
Manganous Oxide,	41.78	41.61
Water,	10.92	11.19
	100.13	99 91

These would determine the formula as being $Mn.\ So_4+H_2o$. This mineral was found in notable quantity in an abandoned mine in Felsobanya. It is named in honer of Szmik, the counsellor of mines —*N. Jahrb. f. Min.* 1877, 729.

Measurement of Water Suspended in Steam.—P. Gazzi, in view of the difficulties introduced into calculations of boiler efficiency by foaming or other mechanical suspension of vapor, has described an apparatus for determining the degree of humidity, as well as for finding the density, either of saturated or of dry steam, at high pressures. His invention was suggested, in part, by the recent investigations of Hirn, Leloutre, and Hallauer.—*Il Politecnico. Eng. and Mining Journal*, xxiv, 297.

MISCELLANEOUS.

Industrial Education as Against Crime, recently discussed in this paper, has also been the topic of a full discussion in the report for September of the Howard Association of England. This Association was founded for the promotion of the best methods of penal treatment and crime prevention The carefully prepared reports of the Pennsylvania penitentiaries furnish the evidences of the much greater want of handicraft skill than of head knowledge in the criminals sent to our penitentiary, and the Howard Association, commenting on this fact, says: "Indeed, popular intellectual education, if separated from its two essential completements—religious and industrial training—is an engine fraught with terrible mischief." The Dutch technical schools are recommended both for England and America. In these schools fourteen hours a week are devoted to reading, writing, mathematics. geography, chemistry and electricity, sixteen hours to manual occupation at carpentering, smithwork, turning, engineering, telegraphy, &c., and eighteen hours to drawing, designing and sculpture. "The lads thus trained are not costly, dependent little walking encyclopædias of dates and longitudes, but young self-retiant, self-supporting men, equipped for victory in the great battle of life." These Dutch schools are not altogether free. a nominal charge sometimes as low as $6 per annum being charged for tuition, and the Howard Association suggests that they might be established in this country, not as philanthropic or gratuitous institutions, but as proprietary and individual undertakings. The Dutch have similar schools for girls, where sewing, embroidery, nursing, housework, &c., are taught, and the Swiss, as was shown at the Centennial Exhibition, pay great attention to the handicraft education of children in the public schools. In this country the public schools are doing a great work in intellectual education, but scarcely anything towards the development of handicraft skill or in teaching children how they may make a living in the world of work.—*Public Ledger.*

A New Mucilage.—The *Journal de Pharmacie* states that if, to a strong solution of gum-arabic, measuring 8½ fluid ounces, a solution of 30 grains of sulphate of aluminum, dissolved in two thirds of an ounce of water, be added, a very strong mucilage is formed, capable of fastening wood together, or of mending porcelain or glass.

—The *Academy*, by way of a cautionary signal to those who are advocating a new and cosmical sort of physical teaching in the English schools, publishes the following truly interesting answers made in the course of physical geography examinations: —"The ecliptic is a circle passing around the earth, whereas beyond that there is always perpetual snow." "The animal that represents the elephant is the rhododendron in South America." "The meaning of the distribution of plants and animals is, those that are extinct are vertical, and those that are to be seen on the surface horizontal." "The chief river of the Alpine region is the St. Lawrence." "When the points of the compass are high we may expect fine weather; when they are low we may expect wet and much rain."

The North Pole Problem.—The return of a Dundee whaler from Davis Straits with a good cargo of oil, has again started the lament in England that no fresh effort is in progress from that country to penetrate to the North Pole. It is reported that the straits are full of floating ice, and the inference is that the Palæocrystic Sea has broken up. Of course people are saying that if Captain Nares had been careful to prevent his expedition from contracting scurvy, the ships might have remained another season in high latitudes, and this year would had the chance of penetrating to a more northerly point. perhaps of solving the mystery of the pole. The tone of the English press on this subject has changed greatly. When Captain Nares returned, the general tendency was to accept his verdict of "Pole impracticable," at all events by way of Smith's Sound. But since the Howgate expedition has been organized, there is evidently a fear that the crowning honor of Arctic discovery may be grasped by Americans.—*N. Y. Tribune.*

Ascension of the Highest Mountains of the Earth.—We hear that Mr. Wiener has ascended Mt. Illimani, one of the loftiest if not the most lofty of the Bolivian Andes. This mountain presents a beautiful aspect from the village of La Paz. According to the authority of M. Pentland, it has an altitude of 7300 metres. M. Wiener has given it an altitude of 6000 metres; M Meehin estimates at at 6400. If these figures be exact, M. Wiener has made the highest ascension ever made in the Andes, in fact anywhere outside of Asia; here it has been surpassed by M. Johnson, who arrived at a height of 6800 metres at the Kingdom of Cachemire, and Mm. Schlagintivett, who in 1855 ascended 6766 metres in the Himalaya. Ascensions by means of balloons have of course exceeded these figures. M. Glaisher arrived at an altitude of 8800 metres, and M. G. Tissandier, in the company of Sivel and Croce Spinelli attained 8600 metres.—*La Nature*, v, 286.

Recording Pulse Beats by Telegraph is a feat recently accomplished by Dr. Upham, who in a lecture lately delivered in Salem, Mass., by telegraphic communication with the Boston City Hospital, exhibited the phenomenon in question by throwing a beam of light upon the wall of the lecture room, which vibrated in unison with the exciting cause.

Petroleum Production.—The Oil City *Derrick*, in its valuable monthly report of oil operations, states that during the month of September 327 wells were completed, of which 60 were dry. On the 1st day of October 519 wells were drilling and 421 starting. The daily production of the entire field averaged 38,900 barrels daily; shipments from the regions during the month averaged 51,900; total stock held in the region now is nearly 2,500 000 barrels. In consequence of the largely increased operations the market has declined.

Labor Consumed by Sewing Machines.—From statistical sources it is estimated that the manufacture of sewing machines employs 100,000 workmen in England, 100,000 in America, and 50,000 in the remaining countries. The number of machines in use throughout the civilized world is estimated at 4,000,000, employing a working force of from 20 to 32 million persons.—*D. All. Polytech. Ztg.*, 442.

Ramie Fiber—Prize by the Indian Government.—The United States Consul-General at Calcutta has forwarded to the Department of State circulars issued by the Government of India offering a prize of £5,000 for the best, and another of £1.000 for the second best, machine or process for the preparation of the Rhea, or Ramie fiber.

The Indian Government is most anxious that full publicity may be given to these offers in the United States, with the hope that American competition may enter into the tests for the prizes. What is required is a machine or process capable of producing, by animal, water, or steam power, a ton of dressed fibre at a total cost of not more than £15 laid down at and port in India, and at a cost of not more than £30 in England. The trials of machines will take place at Saharanpar, Northwestern provinces, in August and September, 1879. Machines must be on the ground ready for work on the 15th of August, in that year.

—The annual product of all the button manufacturing establishments of this country is valued at over $2,000.000 ...Famine-stricken India is being visited by copious rains, which are bringing great relief. The Argentine Republic transacts a trade with foreign nations amounting to $2,000,000,000 annually. The United States gets but $6,500,000 of this amount....The bullion product of the Pacific coast mines, for the past eight months amounted to $30,251,300 ...During the year ending September 1, there were exported and sold from the factories of the United States, 105,000,000 yards of cotton goods, ten times more than was exported the year before.... Oregon yields flax equal to the best grown in Russia or Ireland. ...The cotton-seed oil trade has increased greatly of late years. The article is largely shipped to Europe, whence it is re-shipped to this country in the guise of "pure olive oil."...Mexico is becoming an extensive coffee producer, that industry having almost entirely grown up there within half a dozen years. Vera Cruz alone now exports nearly 6,000,000 pounds of coffee annually.

Preservation of the Yellowstone Park.—In the report of *The Tribune* of the Nashville meeting of the American Association of the Advancement of Science, it was mentioned that a series of resolutions had been passed with reference to measures for the preservation of the natural curiosities of Yellowstone Park. The Secretary of the Interior is charged by law with the maintenance of that reservation as a national park, but no provision has been made of carrying out the intent of the law. The American Association will petition Congress to take active steps to prevent further destruction of the natural curiosities of the park, as their loss would be irreparable, and they have a value to science as a means of setling some open questions. The committee having the subject in charge consists of Professor Joseph Henry, O. C. Marsh and Theodore B. Comstock, Major J. W. Powell and Lieutenant George M. Wheeler. The first meeting of the committee will probably be held within a short time, at Washington. It is to be hoped that the measures for preserving the beauties of the park from the ravages of tourists will be taken before the devastation is complete.

The Woodruff Scientific Expedition.—It is now stated very confidently by the officers of the Woodruff Scientific Expedition, which is to make a voyage around the world, that it sails within a few days of the date announced for starting, October 25. At a recent meeting of the New York Academy of Sciences, resolutions were passed commending the expedition as affording valuable means of education to students, and promising important contributions to science. The resolutions also expressed confidence in the management of the enterprise.

Insanity from Religious Excitement is affirmed, in the *Boston Medical Journal* to be on the increase. Of a total number of 36,983 insane persons examined inmates of 60 different asylums, 2,144 (or 5,79 per cent.) were referred to religious excitement.

—The following is taken from a communication in the Boston *Commercial Bulletin*, upon the subject of "The South American Trade:"

In 1874, of the importations into Brazil, England furnished 46 per cent., France 17 per cent., and the United States 5 per cent. Of Brazil's exports England took 9 per cent., France 5 per cent., and the United States 46 per cent. In 1875 the United States imported from Brazil goods to the amount of $42,033,046, and exported to it goods to the amount of $7.634,-865, a pretty heavy balance of trade against us, which we have to settle for in gold, which is sent to England, France and Germany, and invested in the purchase of goods which should be bought of us, and in which *we are in a condition to sell them on better terms than they can obtain in Europe.* For the same year we exported to Central America, $1,042,784, and imported from it $2,627,359. Our imports for the same year from Venezuela were $5,690,224 and our exports to it were $2,423,254.

—Professor Grote maintains that the original inhabitants of America came from Asia by way of the North during the latter part of the miocene or earlier part of the pliocene, and that this tertiary population spread to the south along the mountainous backbone of the two Americas; that on the advent of the glacial epoch the people living in the extreme North were modified by the change by climate, and were brought down by the ice, and followed it back again to the arctic circle, and that the present representatives of glacial man are the Esquimaux. Through a study of migrations, he reaches the conclusion that the ice must have acted as a barrier to further communication between the continents of Asia and America, and consequently that the civilizations of Central America and of the mound-builders are indigenous.

—Some of the features of our patent system, such as the issue of a periodical containing particulars of recent inventions, have been adopted by the German authorities. In opening the new Imperial Patent Office, a circular has been issued explaining the plan upon which its business is conducted. and soliciting suggestions from other countries where system for the issue of patents have been tested.

—Some idea of the rapid and gigantic growth of the British metropolis may be gained from the statistics recently furnished by Colonel Henderson, commissioner of the London metropolitan police. He says that during the past year 226 new streets and three new squares have been opened and handed over to the police. They extend over 56 miles, 1,074 yards. Twelve thousand nine hundred and thirty-eight new houses were built during the year, and 4,151 were in course of erection; a considerable increase above previous years. One thousand two hundred and forty-seven miles of new streets have been opened in London since 1850, and there seems no tendency to decrease in the annual rate of progression. This increase is accompanied by a similar increase in population, whose necessities for locomotion must be proportionately augmented. As a consequence the slaughter in the streets in one year resembles that of the losses of an army in some small South American Republic. Colonel Henderson adds; that 3,303 persons, suffering from accidents or other causes, were conveyed to hospitals by the police. Quite 130 were killed, and 2,740 were maimed in the streets during the year by cabs, omnibusses, light carts, broughams, vans, etc.—*Engineering News*, iv, 270.

Mineral Wealth of S. W. Virginia.—Edward Shelley writes to the *American Manufacturer*, Pittsburg, a glowing account of the mineral wealth of Southwestern Virginia. Iron, copper, lead and zinc ores are found in abundance. Gold and silver quartz mines of great richness are also found, and some of the most valuable mica mines are found in the same region.

—Two United States war vessels, the Monongahela and the Swatara, determined for themselves, week before last, how much of a bother the Brooklyn bridge will be to well-manned vessels whose top-gallant masts reach above the bridge-level. The Swatara lowered her top-gallants in forty-five seconds. The Monongahela, with a raw crew, put herself in trim in one minute fifteen seconds, and after passing, was only fifteen seconds longer in raising her masts. Comparatively few vessels will have to lower their masts, and they will be but little inconvenienced. The interference of the bridge with lofty sails was one of the gravest arguments of the opponents of the structure.—*Engineering News*, iv, 269.

—The Paris Exposition of 1878 is estimated to cost $7,062,600. ....430,000,000 pounds of resin were produced in this country in 1876.....There are 68 different sewing machines stitches..... Bunker Hill Monument, resting on hard sand and gravel, with a pressure of 5½ tons to the square foot, has not settled perceptibly .....Telegraphic line connecting the ends of Africa, Alexandria and Natal, 3660 geographical miles is proposed. The distance of 840 miles through the country of the savages is required to connect the lines already in operation.....The French revolving cannon, designed to attack torpedo boats, has been improved by the English.....The cork tree is being cultivated successfully in California. This may be the starting of a new industry.....The sponge harvest of Greece, last year, was 240 tons, value, $368,000; there were 150 boats with 1000 men engaged.....Mr. Paul Bert, by a series of careful experiments, has discovered that the changes of color in the chameleon seem to be entirely under the control of the nervous system, and that it cannot help them taking place.....By French law, architects and contractors are held responsible for a period of ten years after the completing of structures constructed by them, if such loss is caused by a fault either in the building or foundations.....Supt. Apgar of New Jersey, reccommends that every school of the State should have a museum, into which might be gathered specimens of natural objects found in its neighborhood, and that the collecting should be done by the pupils.

MANUFACTURING AND INDUSTRIAL NOTES.

—The Howe Scale Works, being about to be removed to Rutland, Vt., work on the new shops at at that place is rapidly progressing.

—The Lamb Knitting-machine Company, Chicopee Falls, Mass., is filling several orders for Germany. Each machine makes three dozen pairs of socks in ten hours.

—A factory is being built at Wood's Hole for the manufacture of fish-flour for the European markets, this flour being a dry inodorous poudrette for manufacturing purposes. The factory will require twenty-two tons per day, and will send out steamers to purchase supplies. The larger the fish the better, and porpoises, blackfish, sharks and dogfish will command the same price per lb. as porgies.

—It is rumored the Whipple File Works, Andover, Mass., have been purchased by a Worcester wire company, on condition that the town give them their taxes for five years.

—The Farrell Foundry and Machine Company, of Ansonia, Conn., has contracted to build another sugar mill, to be completed in sixty days. It is for Haiku Sugar Company, Honolulu, Sandwich Island.

—The manufacture of arms and other munitions of war for Turkey is still rapidly going on. A vessel is about to sail from New Haven with a two million dollar cargo, and another has just arrived at the same port to load with the same materials.

—The A. E. Taylor Manufacturing Company, of New Britain, Conn., are now employing a considerable number of men in the manufacture of a patent combination keyless lock, for cabinet drawers and bank doors; they also make a variety of trunk locks and padlocks of the same character. They have already placed some of their goods in the market.

—E. Remington & Sons, of Ilion, N. Y., have a contract with the present Mexican government for arms and ammunition amounting to about $100,000. They are also to be paid an old bill of the same amount which was contracted by a former government.

—Oscar Barnet, of the Malleable Iron Foundry, Newark, N. J., has received from parties in New York. an order for the the casing of 40,000 pistols. The pistols, it is understood, are to be shipped to St. Petersburg, Russia, to private parties.

The National Steamship Co. has entered into a contract with Kellogg & Maurice, of Athens, Pa, for the erection of an iron freight house. The building is to be 544 feet long and 71 feet wide, two stories high. The second floor is carried by heavy plate girders 64 feet long and 48 inches deep, each supported by 3 posts; and a pair of posts to each girder for roof support. These latter posts stand on an angle of 1 to 12 which is quite a fashionable way of building up the sides of large water depots in Newport.

—Messrs. Grundy Bros., & Campion are increasing their steam power by the addition of a new 5 ft. by 14 ft. double-deck boiler, by Hoff, Fontaine & Abbott, of Philadelphia, which is to be set with the Jarvis Furnace.

—Neafie & Levy, Penn Steam Engine Works, Philadelphia, are building an ice machine of D. L. Holden's patent. The machine is for Messrs. Flood & O'Brien, of San Francisco, Cal., and will be of fifteen capacity in 24 hours.

—Baugh & Sons, Philadelphia, have just shipped by American Line to Liverpool, one hundred tons of the finest bone black, for sugar refining. This, in consideration of the fact that previously all of the finer grade used here was imported, is very suggestive.

—The plate glass project at Huntingdon is said to be progressing favorably.

—A couple of Philadelphia firms have recently sent steam engines and boilers to Germany and the Sandwich Islands.

—Thos. Potter, Son & Co., and G. W. Blebon & Son, Philadelphia, have recently exported to England and Germany about $100,000 worth of fine oil-cloths.

—D. M. Casselberry, Lower Providence, is re-setting the boilers in his tannery, with the Jarvis Furnace.

—The new stacks of the Crane Iron Company are almost completed.

—The Pottstown Iron Company are shipping nails to South America.

John Roach, of Chester, Del., is said to have made a contract for the building of a vessel for the line of ocean steamers, known as the Compagnie Generale Transatlantique.

—The Tredegar Works, Richmond, are doing more work than at any time in the past few years.

Seven coal mines are now in operation between Blounn Springs and Birmingham, Alabama.

—A party of Vicksburg capitalists have a large cotton factory in contemplation for that point.

A narrow gauge road is talked of from Chattanooga, Tenn., to the coal mines of Walden's Ridge.

—The Powell Tool Company, Cleveland, Ohio, report business flush. They are making 700 to 800 axes per day, besides 200 hatchets, picks, &c.

—Tiffin, Ohio, supplies the world with 5,000 churns and 40,000 dozen washboards per annum.

—The New Albany Steam Forge Works, Ind., have received a large contract from the Terra Haute Car Company for car axles.

—The Vulcan Iron Works, St. Louis, Mo., are employing 1,200 men, and have plenty of work for all of them for three months ahead.

—The Missouri Furnace Company, of Carondelet, are preparing to start up again, encouraged by the prospect of better prices for pig-iron.

—The St. Louis Stamping Company is erecting a new five-story brick building, corner of Cass avenue and Second street, as a workhouse, to meet the increased demands for their manufactures.

—The Harrison Wire Works employ about 400 hands and are now compelled to run day and night.

—The Laclede Rolling Mill, St. Louis, started week before last.

We learn that a rolling mill is about to be established in Burlington, Iowa, subscriptions to this purpose having been secured to the amount of $40,000 to $50,000. The requisite supply of coal will be brought by rail for about $2 per ton, and supply of iron will come by river transportation from Wisconsin and Missouri.

The Clinton Bridge Company, of Dubuque, Iowa, has been awarded the contract of erecting eleven bridges of the Howe truss combination on the line of the Volga branch of the Chicago, Dubuque & Minnesota Railroad, under contract for immediate completion.

—Niles is one of the important manufacturing towns of South Michigan. It contains a paper mill, pulp mill, woolen mill, several flouring mills, knitting factories, &c. The woolen mill is owned by J. S. Tuttle, and its product, which consists principally of socks and woolen yarn, mostly blue mixed and scarlet, is sent to New York. The daily consumption of wool is 260 pounds. During the year 21,000 dozen socks are made and 21,000 pounds of yarn. The mill employs seventy-five hands, three sets cards, three self-acting jacks, and nine looms, not all the latter, however, in operation at the present time. The Niles Paper Mill Company manufacture straw wrapping, exclusively, of all sizes. There are three machines, one 62 inches and one 48 inches. On full time the mill turns off 5½ tons of paper per day. A third factory is that of S. J. Boies, who manufactures the "Seamless Sox" He produces 500 dozen socks per week and consumes 75,000 pounds of wool annually.

—Tubbs & Co, rope makers, of San Francisco, Cal, are reported to have discovered a species of cactus, of which portions of California are very prolific, an excellent material for the manufacture of cordage, and have made some fine specimens of rope from the article. It is said that the material can be cultivated without limit on the desert lands of the State where nothing else can be produced, and that it has the advantage of being cheaper than any other rope-making material known.

EDITORIAL CORRESPONDENCE.

EDITORS POLYTECHNIC REVIEW:—

DEAR SIR:

I have read, with pleasure, in one of your last issues, a very interesting article about the "Sondograph," a Brazilian invention by Adolpho P. Pinheiro, of the Brazilian navy, but *not* by F. Echebarn and Pablo Durgos as you stated.

By inserting this correction in the columns of your valuable paper, you will greatly oblige,

Yours, very respectfully,
J. C. ALVES LIMA.

SYRACUSE, N. Y., Oct. 22, 1877.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Franklin Institute.—At the meeting held Wednesday evening, Oct. 17th., the paper for the evening was by Mr. Chas. M. Dupuy, on his direct process for making wrought iron or steel from the ore, in annular sheet iron canisters, on the hearth of a reverberatory furnace. We hope to present a synopsis of the paper at an early date. Samples of Mr. Dupuy's muck-bar, angle-iron, &c., were exhibited. Mr. Hector Orr showed a curved plate for Bullock printing presses, having an electrotype of a cut combined with the ordinary sterotyped letter press. A sample of the Philadelphia *Herald* printed with this cut was shown. A cheap and strong monkey-wrench of great simplicity, (being made of two castings and a tappel nut, and said to cost but nine cents each) was shown for Messrs. Morris, Tasker & Co. Mr. Black, the inventor of the well-known Rogers & Black boiler, which has a central vertical drum and surrounding and connecting tubes, showed a new form of boiler, having the same principle but different construction; the drum being annular, with internal radiating chambers or "leaves," formed by bending and welding together iron plates. A simple and effective post-hole digger, shown for Messrs. Disston & Sons, had on the end of a handle two blades, forming part of a cylinder, and which, after being plunged into the soil to cut the sides of the hole, were drawn together so as to include the earth, and raised with it. The secretary showed a mode prepared by him, of determining the amount of water mechanically suspended in steam—being a by-pass on the steam service pipe, having a chamber in which a copper globe with cocks operated from outside the chamber, was suspended so as to trap a given amount of steam; the globe being removable so as to weigh its contents. Prof. E. F. Moody showed an excellent pneumatic trough for large gas jars; being a water-cap with gum washer, and having two siphon tubes therein. Mr. D. S. Holman's well-known "life-slide" for biological study with the microscope, was shown; consisting of a glass plate having reservoirs and passages so ground therein, that when covered by a very thin glass circular plate, (the enclosed cavity being filled with liquid) the escape of the liquid in evaporating causes the plate to "buckle" and admit air so as to enable small organisms to live for weeks in the slide, under the microscopic field. Some curious corrosive deposits from the steam-chimney of a boiler, were exhibited; the oil used in the engine having been one of the petroleum lubricators called "valveline." Some specimens of felting shown by the Asbestos Packing Co., of Boston, had hair felt protected from burning by a layer of asbestos next the hot surface, and a canvas layer on the other side. Other asbestos products of the some company were exhibited. Some "mineral wool" (slag-wool) and manufactured products, by Mr. A. D. Elbers, of New York, were shown and described; the wool being free from glass "shot" and the material being made into sheets for felting. These products were very fully described in a recent issue of the POLYTECHNIC REVIEW. The Tyson motor for sewing machines, &c., was exhibited; there is a copper coil for a steam boiler, generating steam as used; the feed being made regular and the danger of burning much lessened by an air-chamber reservoir. The engine was of the simple oscillating type; the heat a gas-flame. The Brush and the Wallace-Farmer dynamo-electric machines were shown; the former running. The Brush electric lamp was shown; the carbons being copper coated to diminish consumption and permit of longer and smaller candles; the compensating device being a peculiar clutch attachment operated by a helix and core. The Jablochkoff electric candle (having two parallel carbons separated by a non-conductor, and requiring no machinery,) was shown by Mr. N. H. Edgerton. It has been described twice in this journal; an illustration thereof will soon be given.

The Secretary gave notice that the Pennsylvania Museum and School of Industrial Art proposed establishing schools as soon as the funds could be raised. G.

THE PATENT MODEL SYSTEM.

[The accompanying correspondence, from the (Washington) *National Republican*, is particularly worthy the careful consideration and attention of inventors and legislators. If the abolishment of the model system is to be effected at all in the United States Patent Office, which issues by far the greatest number of patents of any office, now is the time to make the effort.—EDS. REVIEW.]

Reason Why the American Plan Should be Preserved.

EDITOR NATIONAL REPUBLICAN: The recent destruction by fire of so large a portion of the Patent Office models has again revived a movement looking to their suppression in patent applications. Believing that the success of this movement would be a calamity to the public, and deeming the preservation of the present system essential both to the security of the inventor and the protection of the public, I respectfully submit the following considerations in favor of the present rule of requiring models in all cases which admit of represention by model:

This requirement is believed to be peculiar to this country, Canada, the only other Government making a similar requirement, having adopted the plan from us.

In a large model of cases the model is absolutely required for the proper application,as few inventors are capable of delineating their invention by drawings or describing them properly, consequently the requirement is no hardship to the inventor.

Again, the model is the great safeguard to the inventor, and while the drawings may be erroneous and the specification defective, the model still remains as the basis for correction by reissue, and as unmistakable evidence of the construction of the machine it represents.

Again, the drawing may be fraudulently altered. The model is not only more difficult to alter but also serves as an additional check upon the alteration upon the drawing.

After the expiration of a patent the model remains as a defense to the public against the grant of another patent to a subsequent inventor for the same thing. Inventions frequently become obsolete, so that it is difficult to find reference to them, but the models of the Patent Office almost invariably afford a ready reference to the devices desired. In fact, hundreds of the models were duplicated every year for this very purpose.

Again, of the thousands of inventors who visit the Patent Office for the purpose of studying the inventions therein recorded, by far the larger proportion are unable to comprehend drawings, to do which requires a special education, but any mechanic can understand a working model.

A singular tendency exists in this country to assimilate our patent practice to the British system, while in Great Britain a movement is going on in the contrary direction to assimilate their practice to ours, and no feature of our patent system is regarded more worthy of imitation than this very one of forming a great national museum constituting a monument of the inventive genius of the country.

The constantly increasing space required for the models is also urged as a reason in favor of their being dispensed with, but that is a consideration unworthy of a great nation, proud of its inventors.

The patent system has long since outgrown the capacity of the building in which the Patent Office business is transacted, and it is a mere question of time when the Government shall undertake the erection of a building capable of accommodating the demands of the only Department of the Government that is not only self-supporting, but which has a handsome surplus to its credit in the Treasury, and the inventors of the country believe that they have a right to demand that this fund shall be devoted to the erection of such a building.

Respectfully yours, W. D. BALDWIN.

Reasons Why the Present Plan Should be Modified.

EDITOR NATIONAL REPUBLICAN: My attention has been directed to the letter in your issue of the 5th inst., of Mr. Baldwin, whose opinion that it would be a calamity to dispense with models in the Patent Office, does not agree with the views entertained by many who are interested in patent matters, the writer among the number.

Let me say in the outset that for more than twenty years I have advocated, whenever opportunity offered, the advisability of dispensing with models except in special cases.

Mr. Baldwin's letter states that "in a large majority of cases a model is absolutely required for the proper preparation of an application"

In *exceptional* cases a model may be desirable for this purpose, and for a proper examination in the Patent Office.

In the *majority* of cases applications for patents can be prepared by competent attorneys from sketches, drawings, and descriptions and without the aid of models.

We have the published statement of the Hon. Commissioner of Patents, to the effect that the recent destruction of models will not delay the business of the Patent Office, as *examinations are made from drawings.*

It is further stated in the letter that "few inventors are capable of delineating their inventions by drawings or describing them properly."

This is unjust to inventors and not in accordance with the writer's experience. There are very few inventors who cannot give sketches and explanations of sufficient clearness to enable a competent patent solicitor to understand the inventor's meaning and to display the invention properly on paper without the aid of a model.

The statement that the demands for models "*is no hardship to inventors*" is contradicted by the general compaint of about the loss of time and money which the compliance with this demand involves. The opinion that models are useless is almost universal among inventors.

Again, the letter states that "a model is a great safe-guard to the inventor, and that while the drawings may be erroneous and the specifications defective, the model still remains as the basis for correction by reissue, and as unmistakable evidence of the construction of the machine it represents."

This looks like an encouragement of the slovenly practice of making such imperfect drawings that they cannot be interpreted without the aid of models.

The advocates for dispensing with models insist upon it that the Patent Office should demand the most complete and unmistakable drawings; these are much better safe-guards both for inventors and the public than models, which are generally more or less fragile, are liable to be injured, parts being frequently lost; whereas, drawings are photo-lithographed so that an accident to the original would be of very little consequence.

As another reason why the model system should be maintained the letter states that "the drawing may be fraudulently altered," that "the model is not only more difficult to alter, but also serves as an additional check upon the alteration of the drawing."

He would be a brainless rogue who attempted to alter an original drawing when there are numbers of copies in the office and in different parts of the country, any one of which would afford the most infallible means of detecting the fraud. As the affairs of the Patent Office are now conducted it would be a hazardous matter to attempt to alter a drawing; it could not be done without the connivance of one or more of the officers.

It would be a much easier matter to alter a model: it might be distorted while it is handled, parts might be removed without detection, a little tool dexterously applied might change one or more of its features, and a device might even be added without observation.

Again, the letter states that "after the patent has expired the model remains as a defense to the public against the grant of another patent to a subsequent inventor for the same thing."

This would seem to imply that a drawing cannot be made to represent an invention as well as a model, which is very far from the case. If justice be done to an inventor by the man who instructs the draftsman and prepares the specification there will be nothing omitted for a subsequent inventor to claim.

It is declared in the letter that "by far the largest proportion of inventors who visit the Patent Office to study inventions are unable to comprehend drawings, to do which requires a special education, *but any mechanic* can understand a model."

If the intercourse of the writer of the letter with mechanics had been familiar, he would not have ventured to make the above statement, which is not very complimentary to the intelligence of the men who constitute the bulk of our inventors.

It is a notorious fact that mechanics, and those connected with mechanical and manufacturing pursuits are of much more apt in understanding drawings than tradesmen or professional men. It is next to impossible for a man to be a good mechanic without being able to understand mechanical drawing.

The letter refers to a movement in England to assimilate the practice there to our own, and states that "no feature of our patent system is regarded more worthy of imitation than this very one of forming a great national museum, constituting a monument of the inventive genius of the country." This, I presume, points to the South Kensington Museum in London.

The English Patent Office never demanded models; in the many propositions to amend the Patent Laws of that country there are no suggestions as to models.

Every encouragement, however, is given to inventors, manufacturers and mechanics to deposit in the museum substantial morking models of really useful and important inventions.

We shall never make a mechanical museum worthy of the name by piling up three or four deep in glass cases, fragile dummy models made of materials which afford the best mediums for the spreading of conflagrations.

Comparatively few of the models in the Patent Office are correct representations of the machines to which they relate; there are thousands of models so imperfect that they are better calculated to mislead than instruct; the practical working models are few.

There are no advocates for the *total* abolition of models in the Patent Office.

It might, in exceptional cases, be an advantage to the inventor, attorney and examiner to have a model in connection with an application for machines for textile fabrics, for instance, or in applications relating to printing or telegraphing operations, and doubtless in other cases.

It may be advisable to furnish models in contested and appeal cases, but there is no excuse for demanding a model with *every* application.

Inventors certainly do not wish to be taxed with the cost of models.

The public does not demand models; the members of the community who desire to investigate patented inventions generally understand drawings, and if copies of the drawings of patents were arranged and bound in classes, and as accessible to the public as models now are, they would better serve to give the information sought for than models.

Examiners do not require models execpt in special cases; for examinations are, with few exceptions, conducted by the aid of drawings and specifications.

It may be said that models are useful in facilitating the preparation of applications by attorneys. True enough, perhaps, in meny cases, but it is not to be supposed that an attorney of the ability and experience of Mr. Baldwin can for a moment entertain this as a reason for continuing the serious tax upon inventors, which the requirement of a model in every case certainly is. There is not more than one application in thirty that requires a model for its elucidation in addition to the drawing.

The law does not contemplate the demand for a model in every case; formerly the law was imperative as regards the depositing of models; now, however, the Commissioner can, at his discretion, dispense with them.

All that those who are opposed to Mr. Baldwin's views ask for is, that the Commissioner shall dispense with models in all cases in which they are unnecessary, and when the drawing and specification suffice to accurately display the inventions.

By all means let us have a grand national museum as a monument to the genius of inventors.

Huddling together indiscriminately in glass cases, complete, imperfect and dummy models of useful, useless and ridiculous inventions, is not the way to create an attractive or utilitarian mechanical museum.

Let it be known that the halls of the Patent Office are open for the display of accurate and durable working models made in the best style, and the makers of successful patented machines would be so ready to avail themselves of the opportunity to exhibit good representations of them, that in two or three years we should have national museum equal to, if not excelling, that in South Kensington.

The contents of the museum would be worthy of scrutiny, for it is not to be supposed that models of useless or impracticable inventions would be on exhibitions there, for unsuccessful inventors would not be apt to increase their losses by making costly models of their inventions.

Let us dispense with useless models to make room for a creditable display of what is useful and meritorious. *

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FRAZER'S TABLES FOR THE DETERMINATION OF MINERALS. (Revised Edition) Philadelphia. J. B. Lippincott & Co., 1878. (119 pp. 8 vo), $2.00.

The Tables of Weisbock, upon which the author has much improved and enlarged, afford the student and amateur mineralogist, by far the readiest guide for the determination of a doubtful mineral. Some of these hand books for the use of students, are based, like that of Blum for example, upon the crystallographic peculiarities of minerals; and their utility is therefore limited to the determination of said specimens, as are distinctly crystallized; but since comparatively few of the minerals that come to hand outside of the cabinet, are distinctly crystallized, the usefulness of such a classification for practical work is very limited. Works like that of Blum, therefore, while they serve the excellent purpose of exercising the student is crystallographic study, afford but little help to the service in mineralogy outside of the lecture room.

Others like V. Kobell, have taken the place of depending entirely upon the chemical behavior of the minerals, and have given the student, with the help of an elaborate and refined system of division and subdivision, by the application of simple reagents, a method tolerably certain, in the hands of those who carefully study and use it, of reaching a correct result by a process of exclusion. This system, although decidedly more useful than the crystallographic one before spoken of, inasmuch as it takes in *all* the mineral species, is in our opinion defective in that, in taking no account of a host of distinguishing and often characteristic physical properties. Color—lustre, streak, crystallization, cleavage, hardness, &c., &c., it does not promote that education of the eye, which constitutes most of the difference between the dabbler and the expert mineralogist.

A more rational system, obviously, would be one by which the differentiation of mineral species into subdivisions shall be carried to the furthest extreme, upon the basis of their physical properties; and where this process fails in identifying the mineral, the more troublesome chemical behavior shall be appealed to for the decision as a *dernier resort.* This plan has been followed in the work under consideration, which we find to be very complete and reliable—affording the student who will use it intelligently, the advantage of a very refined system of physical selection (if we may coin a phrase that will express our meaning), which will enable him in the majority of cases to determine his species, without resort to the objectionable *impediments* of the laboratory, Where the blowpipe and other chemical accessories are necessary, however, to be appealed to to decide a troublesome case, the student will find the required directions given for this purpose.

The Tables of Professor Frazer are based upon those of Weisbock, but the author has amplified and improved on service particulars, and we can recommend it with much satisfaction to all students of this interesting branch of science. W.

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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, NOVEMBER 3, 1877. No. 18.

SUBTERRANEAN LONDON.

The cuts which accompany this article will give our readers some idea of the various works which are effected beneath London. And now that they are ready and in operation, people find it difficult to comprehend how it was possible to pass so long time without them. They have cost much money, but the subterranean railway is a lucrative enterprise; and if the other works are not of equal profit, the facilities which they offer to the multitudes who inhabit the great capital of the world are certainly worth the money they have cost. Of these works the principal, as well as the first projected, is the Metropolitan Subterranean Railway. It was projected about the year 1860. To the capital stock of the company, which proposed to execute it, the Great Western R. W. Company subscribed £200,000, on account of its accession to its traffic in the centre of the city; and the corporation of the city of London subscribed an equal sum.

On the 10th of January, 1868, the permanent way was opened for the transportation of passengers between Paddington and Farrington Streets. At first, the directors of the Great Western Railway took the management of the line; but after the 10th of August of that year it was worked by the Metropolitan Company.

This subterranean railway has had a grand success. In the first year there were transported on it nearly 9,500,000 passengers. Two years later the number of passengers annually transported was almost doubled, and now, the line making almost the entire circuit of the city, about 50,000,000 persons avail themselves each year of this means of transit from one part of the city to another. On working days 350 trains make the round of this line; and on Sundays 200. So complete and perfect is the system of signals used to give exact notice of the respective positions of the various trains, that they can be despatched with entire security at intervals of two minutes.

To the mind of one not having seen this subterranean tunnel, the question would naturally suggest itself whether the passengers of this line are not subjected to many inconveniences in traveling thus in a dark tunnel and breathing the gases generated by the fires of the engines. These fears have, however, no foundation. The cars are lighted with gas carried in rubber bags in wooden cases, and fastened to the roofs. The bags are subjected to the pressure of a weight, and thus the gas is conducted by tubes to all parts of the car, furnishing a brilliant and safe light. An index always shows what quantity of gas is contained in a bag, and when it is necessary to refill the bags, it can be done at the terminal station in two or three minutes.

The locomotives are light and powerful machines, made so that the steam does not escape in the stack, as in ordinary locomotives, but condenses in tanks attached to the sides of the engine, and which contain 4,500 liters of water, a quantity sufficient for the going and coming of the train. The fuel is coke, prepared especially for this line, and so coked as to give no sulphurous gases. And there is none in the subterranean line in all its extent; a great part of it is, and especially at the stations, open to the light of day.

The first-class "coaches" carrying ninety passengers each, those of the second-class eighty and more.

The traffic on this railway is regulated so systematically that at the terminal station, called "Mansion House," where ground is so dear that the space belonging to the company is very limited, having place for only three platforms and three lines of rails, three trains have entered the station, discharged their passengers, taken others, and been supplied with gas, all in the space of six minutes. In this station thirteen trains come and go each hour from eight in the morning to eight at night.

The first of the four cuts represents in transverse section the works constructed beneath one of the streets of London. Here we see, first, the concrete foundations for the sewers and for the gas and water pipes and telegraph wires; one also sees the galleries, the means by which they are ventilated, and the means adopted to prevent the noxious gases generated by the decomposition of the sewage materials from rising to the surface by the pipes which conduct the rain water from the street by the subterranean galleries, and one sees also the system of paving adopted on many of the streets of the city. There is first a layer of brick; above that another of coarse stones; this is covered with another layer of concrete made of hydraulic lime and fine gravel; and above all this is placed the pavement of granite parallelopipedons.

In Fig. 4 the upper railway is part of the Metropolitan Railway, and the lower is part of the Midland and Great Northern. When we reflect that the upper line is thirty feet below the surface of the ground, we will understand that truly it is one of the greatest works of engineering to construct a railroad at a still greater level. And this is only a part of the grand enterprise which offer so great convenience to London, and which now appears almost absolutely necessary.

Fig. 1.—HOLBORN VIADUCT.

Fig. 2 represents Kings' Station, where, besides part of the principal line, one sees part of a branch. Of these there are so many that there are very few places in all the great city of London (containing few less than four millions of inhabitants) that have not easy access to one or the other of the many stations of the subterranean railway.

Fig. 3 shows part of the railroad, and besides this some of the greatest of the subterranean works, which are one of the glories of London. It represents a section of the famous Thames tunnel. When the subterranean railroad passes by this tunnel, its roof, in place of being of a semi-circular section, as in the other subterranean parts, is formed of straight iron beams, placed transversely eight feet apart in the spaces between them. The roof is of brick in a low arch.

In gallery 1, which is nine feet in height, we find the gas and water pipes, and the

telegraph wires. In the first cut we see that in some other parts of the city these galleries are much more elaborate. They are easy of access, having many places for entry; at a slight distance apart are iron gratings in the top, to permit daylight to enter and where it is not possible to have these gratings, the galleries are lighted by gas.

2 shows a sewer-conduit. Of these there is in the whole city an immense network; being in total extent at least 1,300 miles, or 2,091 kilometres. The section of the greater part of the galleries is circular, of the rest, elliptical. The smaller ones are four feet in diameter; the larger measure twelve feet in height, and nine and a half in width. The thickness of these walls, which are made of brick and cement, varies from nine and a half to twenty-seven inches.

In the construction of the sewerage works of London were employed 818,000,000 bricks and 180,000 cubic yards of concrete; there were removed 3,500,000 cubic yards of earth; and the cost was £4,100,000. The total force of the steam engines employed to work the pumps is numerically 2,380 *HP.*, and they consume annually about 20,000 tons of coal.

To give an idea of the means employed to conquer the difficulties encountered in the construction of this work, we may mention only the grand aqueduct of wrought iron, with a span of 150 feet, and which weighs 240 tons, which conducts the sewage stuff from above the Metropolitan Railway to Farringdon Street.

4 of Fig. 3 shows the tubes of the Pneumatic Railway, the company of which was organized in 1868, with the end of uniting various parts of the city by tubes, and transmitting through them, by air pressure, letters and small packages. It united also Euston Square and the General Post Office, at High Holborn, where the principal station was. But the enterprise was not very successful. After an experience of 18 months it was evident that it would not give a reasonable profit, and it was abandoned.

The tubes, however, were in their places, and being below the tunnel of the railroad, they were employed, with the pneumatic machinery, which had served to transmit the letters, to ventilate a part of the tunnel where formerly the air had been very vitiated. But it is not at all improbable that the time is not distant when the pneumatic system will be an accomplished fact, with a basis as secure as now steam propulsion has.

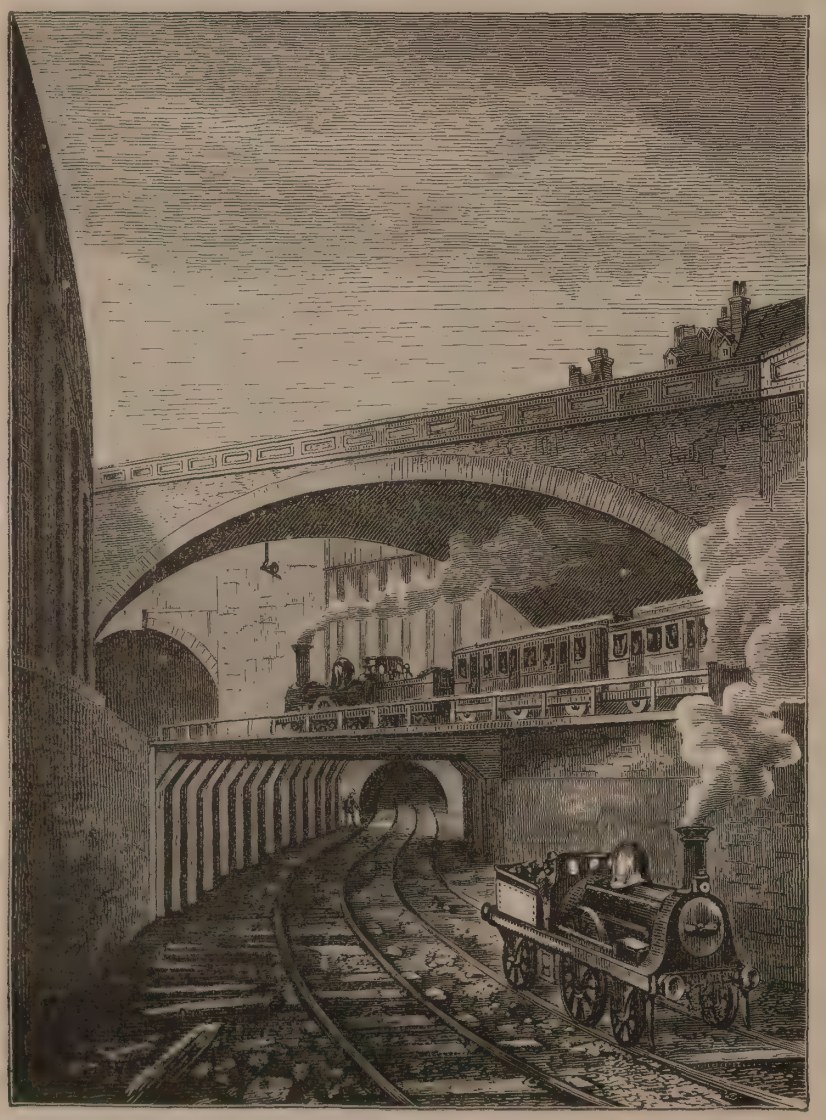


Fig. 4.—ENTRANCE TO THE TUNNEL AT CLERKENWELL.

[The foregoing is translated from the Portuguese of the *Revista Industrial*; to which we acknowledge our indebtedness for the engravings.] G.

DUST FROM HIGH ALTITUDES.—M. Gaston Tissandier and his brother have made an ascent from Giffard's aeronautical gas-works, for the purpose of collecting the dust floating in the atmosphere. The method employed has been to condense the moisture of the air and analyse the water and ice thus obtained with a microscope.—*Nature.*

Fig. 2.—KINGS' STATION.

AN ENAMELED GALVANIZED IRON WATER-PIPE.

The problem which, next to the great question of drainage and sewerage, is a source of constant anxiety to sanitary engineers, is the insuring of the purity of the water supply of cities and towns. No expense has been spared to insure this desideratum.

Elaborate and costly aqueducts are built to convey the mountain streams and inland lakes, in all their purity into reservoirs, undefiled with the refuse of factories or the sewage of suburban towns; or where this, perchance, cannot be done, approved systems of filtration and aeration, upon the large scale, are often adopted to remedy the evils of sewage contamination.

But precautionary measures of the nature above described are frequently rendered quite valueless, by the fact that after so much forethought expended to effect its accumulation, free from hurtful contamination in the reservoirs, it is not unfrequently impregnated with dangerous impurities on its way through the service-pipes to the place of consumption.

We refer here, mainly, to the dangers arising from the very general use of lead for the purpose named, although we entertain the conviction that, under most circumstances, it is harmless enough, while its cheapness and admirable flexibility give it decided and peculiar advantages over every substitute that has yet been offered. It is not to be denied, however, that, under certain circumstances, lead pipes do exert a decidedly injurious action upon water which has been passed through them and which is subsequently used for drinking and culinary purposes; and we admit that a substitute for the lead pipe, still almost universally used, which would combine with equal adaptability, freedom from danger of possible contamination, would be very desirable. The peculiar circumstances under which lead service-pipes may injuriously contaminate drinking water, we will endeavor to indicate with the preamble, however, that an excellent proof of the fact that the dangers to health from this source have been considerably exaggerated is afforded by the extent to which it is still employed.

A fresh surface of lead is quickly attacked by pure water, an oxide being formed which is somewhat soluble; in time, however, a thin film of this compound (which speedily changes into carbonate) is formed upon the pipe, adhering tenaciously to its surface and preventing any further action. It is, therefore, dangerous to keep or supply rain or soft water in leaden cisterns, or through leaden service-pipes, for the reason above noticed. A minute quantity, however, of any carbonate or sulphate, which spring or river waters usually contain in the form of bi-carbonate or sulphate of lime, magnesia, &c., speedily arrests the corrosion of the lead by a formation of a film of carbonate or sulphate, both of which are quite insoluble in the water. If, however, ammonia salts are present, (and sewage contaminations are sure to give rise to its formation), this protective influence of the carbonates or sulphates is lost, and the corrosion of the lead takes place rapidly.

To obviate the trouble here described, lead pipes have been lined with tin, which is less liable to corrosion from the sources named, and whose salts are comparatively harmless. Such tin-lined lead pipes have been introduced both in Europe and America, and we believe with good results. They are, however, open to the objection of being expensive.

Iron pipes are cheap, and, of course, quite free from danger, as water conduits, but are open to the objection that they will speedily rust, and that they do not afford that convenience of bending, making joints, &c., which gives to lead its great popularity for this purpose. It is an open question, however, whether these advantages of lead are not offset by the serious dangers to health, for which they must be occasionally held responsible, and whether the use of iron pipes would not be on the whole an advantage.

These points are certainly worth the attention of sanitary engineers.

In this connection, we may remark, incidentally, upon a peculiar mode of protecting iron pipes, intended for water conduits, which has lately been brought to our attention, and which appears to possess interest enough to warrant noticing. This pipe* is galvanized outside and enameled inside with what is affirmed to be a silicious glaze or enamel, free from lead, which is claimed to be able to withstand acids and alkaline treatment, and the extremes of hot and cold.

The exterior galvanized coating will naturally considerably prolong the life of the pipe against rusting; while such a glazing as this is claimed to be, would certainly insure the water supply from the reservoir against contamination on its way to the point of consumption. W.

*Patented by Frederick Chase, Philadelphia.

SUBTERRANEAN LONDON.—Continued from page 206.

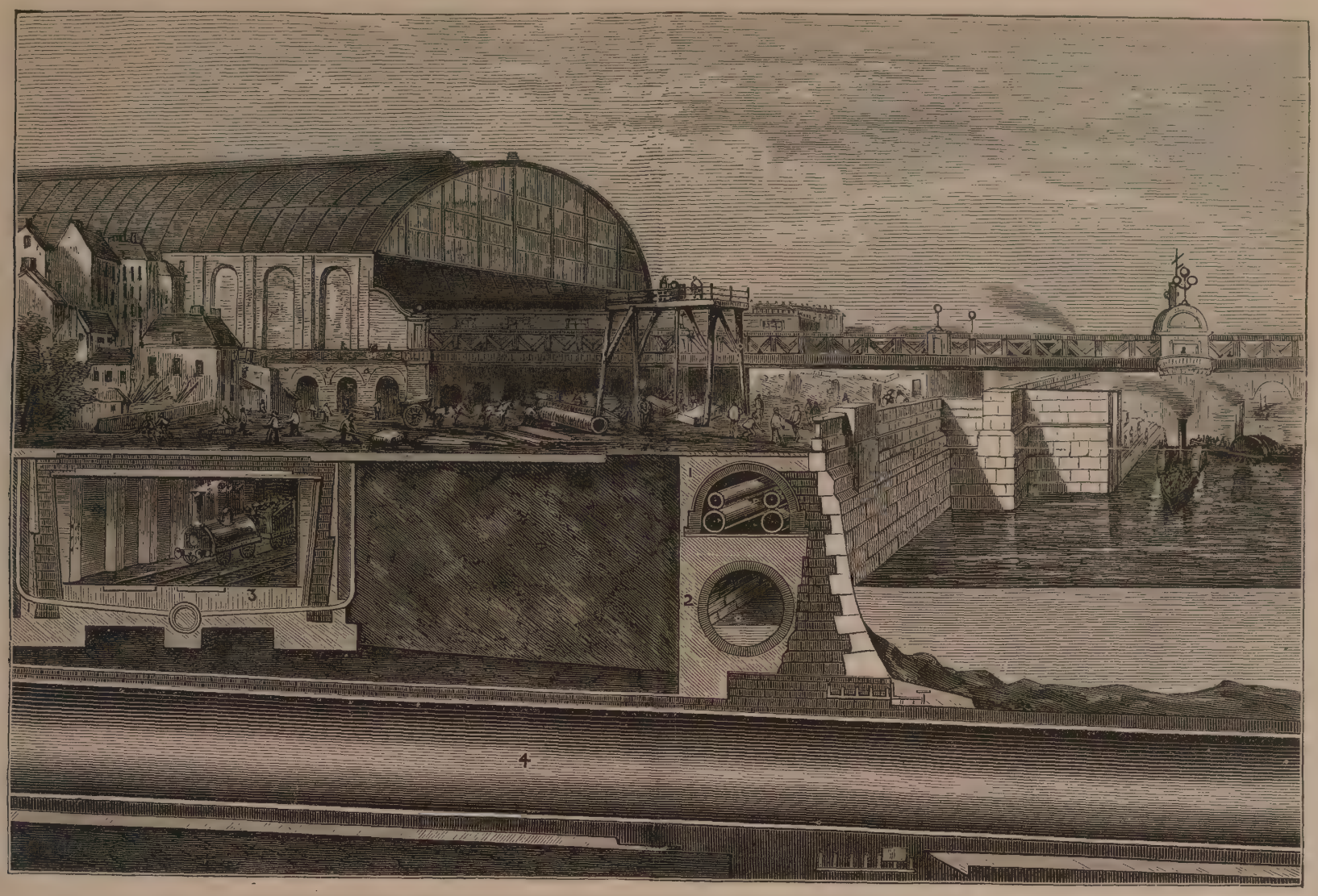
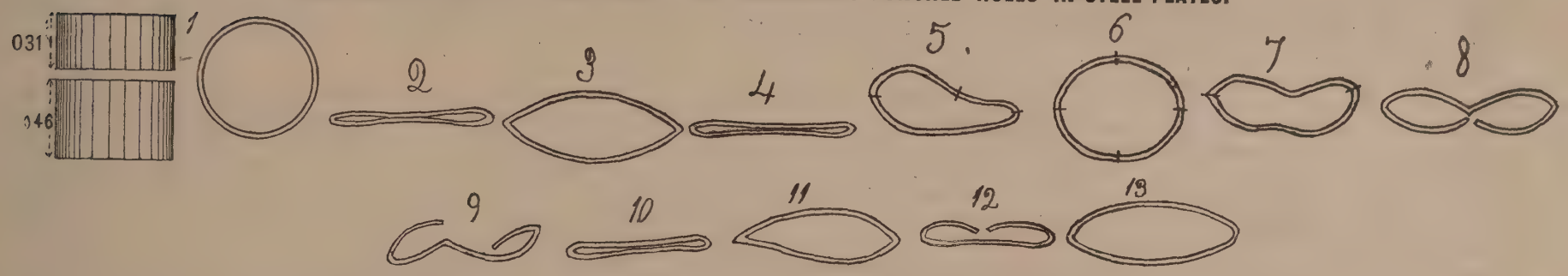


Fig. 3.—SECTION OF THE THAMES TUNNEL.
1.—Subterranean Gallery for the Gas and Water Pipes, Telegraph Wires, &c. 2. Sewer. 3. Railway Tunnel. 4. Pneumatic Railway Tube.

EXAMINATION INTO THE CONDITION OF THE MARGINS OF PUNCHED HOLES IN STEEL PLATES.



In our last article* we showed that the injurious effects of punching natural Bessemer plates were removed by drilling away the margins of the holes to a width of .039 inches.

We now investigate the condition of the rings surmounting the holes in various steels, under various conditions.

Bessemer plates .31″ and .46″ thick had put through them holes of the same diameter—some drilled, some punched and enlarged by .078″. The part outside this region was then carefully turned off in a lathe until they were obtained rings about .019″ thick. (See Fig. 1.) By trying to flatten these rings, very different results were obtained. The rings with drilled holes completely flattened under the hammer, without any cracks, (Fig. 2); in trying to open them out, cracks showed at each end as in Fig. 3. The punched and reamed rings stood the same test as seen in Fig. 4; its first crack in re-opening being when Fig. 5 was assumed. These experiments showed the drilled and the punched and reamed rings to be in the same physical condition. Rings with punched holes were stiffer to flatten, and cracks showed at once (Fig. 6.) Figs. 7, 8, 9 show some of these "punched" rings after complete rupture; each of the pieces is an arc of the original circle. The last rings were harder to file than the first; and, indeed, *scratched the plate they came from*, which the drilled or reamed rings would not do. The file felt no difference between the drilled or the reamed rings, and the plate.

Heating the rings cherry red in a gas furnace, letting them cool, and then testing as before, gave it punched holes results as in Fig 10; cracking when as at Fig. 11, on opening out. A punched ring cut lengthwise and developed, and bent again so as to extend the interior, were then flattened as in Fig. 12, without cracking; further deformation caused cracks. This last test shows that the punch does not make any crack on the edges of the hole. This demolishes the theory that punching causes incipient cracking. Martin plates were found as brittle as the Bessemer when cut away in the lathe in the same way.

The effects of annealing on rings surrounding punched holes would indicate a great improvement by it, on the apparent resistance of punched plates. These results were verified with Bessemer specimens 1.95″ wide, which, after annealing, broke as follows:

	Resistance per square inch.
	Tons.
Punched and annealed, ...	29.50
Drilled "	30.01
Punched, enlarged and annealed, . .	30.32
Punched and *annealed*, only, ...	24.49

Annealing, then, brings the steel back to the same state as if it had been drilled and planed instead of being punched.

Strips of Bessemer and of Martin steel, some with punched and others with drilled holes, gave, after tempering and annealing, the following results:

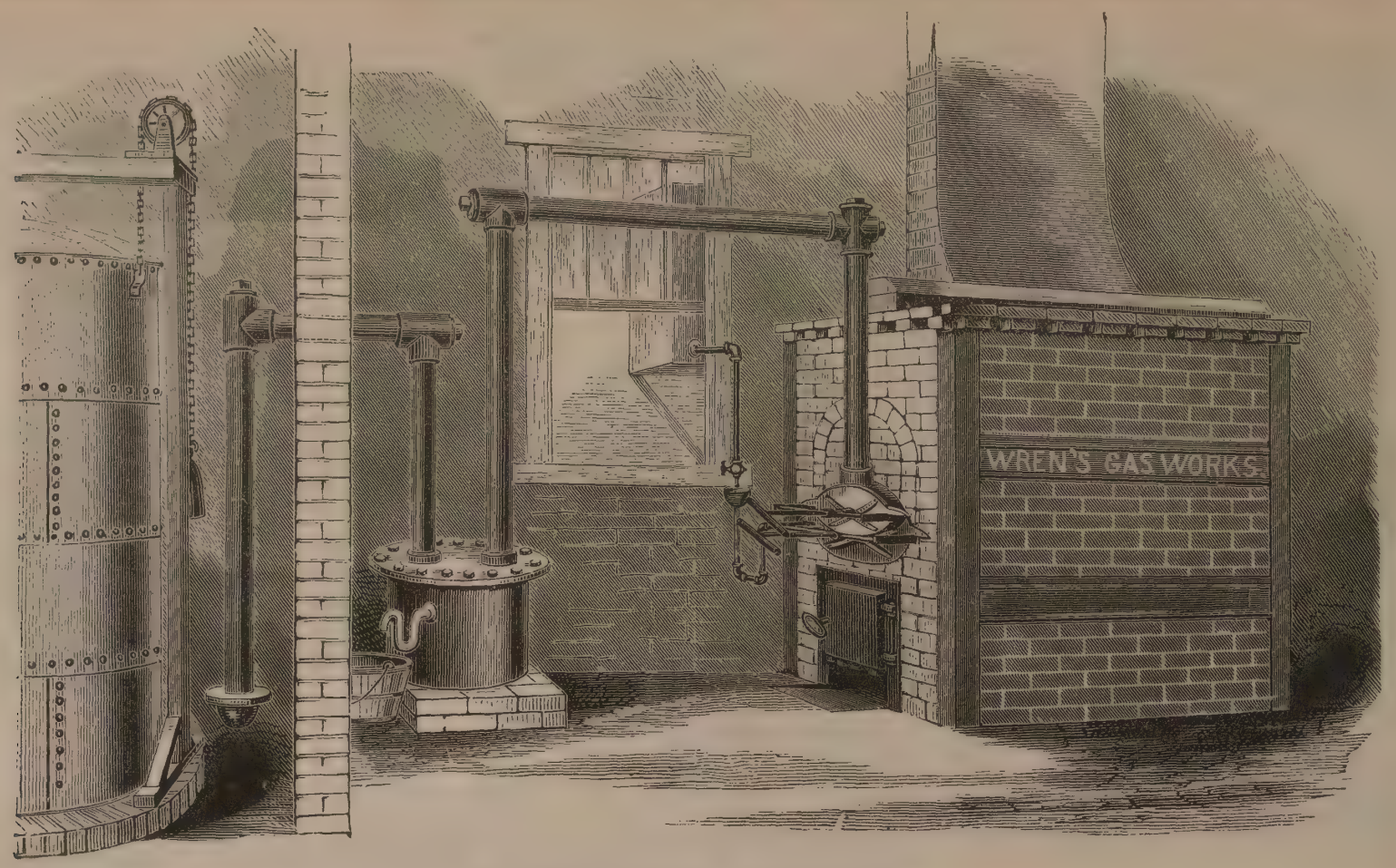
	Resistance per Square Inch	
	Bessemer.	Martin.
	Tons.	Tons.
Drilled hole, ...	30.13	26.33
Punched hole, ...	35.53	30.32

It is probable that these last specimens were not annealed at a high enough heat to draw all the temper.

So far, then, we have learned not only (1) that the efforts of shearing and punching are local, extending less than .039″ from the sheared or punched edges, and (2), that tempering destroys the evil effects of punching by bringing the metal to the normal state from which it had been disturbed; but (3), that no cracks exist in the altered region, and (4) that annealing alone or after tempering destroys as tempering alone does, the evil effects of shearing and punching. To explain these we must consider that the shears or the punch produces an intense local pressure. On account of this pressure (1) the metal's elastic limit is reached, (2) part of the mechanically mixed carbon is dissolved, effecting a real tempering or hardening in the two edges of sheared plates, and in the interior of the holes and the exterior of the punchings. This tempering is more intense than that caused by rapid cooling; in fact, a ring surrounding a drilled hole and rapidly "quench-tempered" gave only the deformation shown in Fig. 13 before cracking.

This thorough analysis of the facts connected with punching and shearing, will enable us in another article to consider thoroughly the reasons for all the results obtained. G.

*Page 199, No. 17, of current volume; date of Oct. 27.



GAS FROM PETROLEUM.—WREN'S PROCESS.

The abundance and cheapness of petroleum in the markets of the eastern portion of the United States, long ago suggested to inventors the desirability of utilizing its eminent illuminating qualities in the production of a cheap lighting gas, to take the place of coal gas. The result has been the invention of a great number of devices and processes, some of which have been practically successful, others indifferently so, while others again—and in this category we may include the greater number—have turned out to be quite worthless.

The difficulty to be overcome in the solution of the problem of producing a practically useful petroleum gas—that is, one that shall be able to present all the good qualities of coal gas, at lower cost—is chiefly that the gas produced will consist largely of very dense hydrocarbons which, although possessing admirable illuminating qualities, will be liable, especially during seasons of cold weather, to condense in the supply pipes, thus rendering the light very variable in quality, and clogging the pipes. The public is perhaps most familiar with petroleum gas, through the instrumentality of the numerous forms of so-called "gas machines," which, generally speaking, operate upon the principle of forcing, by mechanical means, a regulated stream of air over and about an extended surface of gasoline, one of the light products of the petroleum rectification. These devices properly should be styled "vapor machines," and not gas machines; the air in its passage over the oil surface in the "carburetter," simply charging itself mechanically with as much of the vapor as is naturally given off at the temperature of evaporation.

This quantity is, of course, very variable, according as the temperature is high or low, being in seasons of extreme heat sometimes so excessive as to cause inconvenience from smoking in burning, if not specially guarded against; while in seasons of extreme cold, considerable difficulty is found in keeping up the evaporation to the extent of affording a good light.

The attempt to store up this mixture of air and petroleum vapor in gas holders, as in the case of coal gas, introduces the difficulty that the two ingredients of the mixture will commence to separate or stratify, when condensation speedily follows The same process takes place, though to a limited extent, in the supply pipes, reaching its maximum during seasons of extreme cold.

In spite, however, of these difficulties, these devices, the best forms of which are provided with elaborate improvements to guard against the difficulties above numerated, have generally given satisfactory results, and are deservedly popular for lighting on the limited scale, in private dwellings, hotels, factories, &c., remote from cities, where the luxury of illuminating gas cannot be had.

Other systems, with which the public is not so familiar, involve the gasification of crude petroleum, with the aid of heat, in retorts of various constructions, sometimes used in connection with the ordinary coal gas plant, to enrich the common burning gas, and at others used independently.

One of the most successful of these plans is that illustrated and described in what follows,* and which has received from numerous quite trustworthy sources an excellent commendation for its suitability, on the score of economy, convenience and effectiveness in the lighting of towns and villages.

The engraving shows the several parts of the apparatus, and their disposition. A tank of petroleum, located outside of the furnace-house, delivers a regulated stream of crude petroleum into a trapped pipe leading to the retort. This trapped pipe at the same time acts as an automatic safety valve. If from any cause the stand pipe referred to, or any part of the apparatus becomes choked or stopped up, the material will not enter the retort. The pressure on the retort cannot at any time exceed 8 inches of water pressure, less than ½ lb. to the square inch. This is set in brick-work, and heated in the ordinary way. A stand pipe, leading from the upper end of the retort, passes the gas into a condenser, where the readily condensible tarry products are accumulated, from which the finished gas is passed into the gas holder. The size of the apparatus, the number of retorts, &c., will depend upon the quantity of gas to be supplied.

The retort contains a series of communicating chambers, the crude petroleum being vaporized in the first, then passing successively over the heated surfaces of the remaining sections, and emerging at the point before described. The object of this artifice is to effect, as far as it is possible so to do, the permanent gasification of the petroleum, by subjecting the vapor issuing from the first chamber, to the successive action of highly heated surfaces, and goes far to explain the statements emanating, with positiveness, from a number of towns where the Wren system is in use—that no serious difficulty is experienced from condensation. On theoretical grounds, it appears to us that the only possible method of accomplishing the result in view, would be by some such plan as is here employed.

The gas made by this process is, as may be imagined, extremely rich, and requires therefore to be burned through burners of small capacity, which is necessary to give a high illuminating power without smoking. The process is said, on what appears to be good authority, to be giving very satisfactory results on the score of economy and effectiveness, in a number of towns, factories, &c., in which it has been introduced.

In conclusion we add, for the consideration of our readers, the following salient points from a number of claims made by the inventor:

1st. Great economy as compared with coal gas.

2d. Compactness; only one-tenth of the ground space being required for an equivalent amount of light, as compared with the coal gas plant.

3d. Simplicity—no skilled labor being required.

4th. Safety.

W.

* The process is that of W. C. Wren, Cor. Jay and Water Streets, Brooklyn, N. Y.

A CURIOUS CASE OF LEAD POISONING.

We learn from the *Medical Record* that a popular district of Paris has lately suffered from an epidemic of lead poisoning, which presents some noteworthy features. Dr. Ducamp has had sixty-five of these cases under observation, and he made them the subject of a paper read before the *Societe de Medicine Publique* on July 25. The patients belonged to all classes of the population; in some families all the members, both old and young, were affected. After careful investigation, Dr. Ducamp found that all his patients were served from the same bakery, and, as he could positively exclude all other methods by which the poison could be introduced into the system, he came to the conclusion that the bread was the agent morbi. Chemical examination showed that it contained lead; it was evident, however, from the character of the baker, and from the fact that he and all his family were among the most severely affected victims, that the lead was not placed in the bread with criminal motives, while, on the other hand, the fact that the water and flour used were the same as were used by the neighboring bakers, whose bread was not poisoned, showed that these substances were toxic. Dr. Ducamp finally ascertained that the baker had been making use of old wood taken from demolished buildings to heat his ovens, and here he struck the root of the trouble. This wood had been repeatedly painted with white lead, and when it was consumed by the fire an oxide of lead was formed, which was desposited in a pulverized form on the floor of the oven. When the embers were withdrawn, and the bread put in the oven, the oxide of lead probably adhered to the bottom of the latter, and was removed with it. The correctness of this theory was confirmed by two striking facts: The persons whose duty it was to brush the bread, and who must have detached a portion of the lead and inhaled it in the form of dust, were the first to be affected and had the most severe attacks. Again, in one family there were two women, of whom one ate only the soft parts of the bread while the other ate the crusts. The former escaped entirely, but the latter was attacked so severely that her life was in danger.—*The Iron Age.*

NITRIC AND CHROMIC ACID BATTERIES.—CONTINUED.

J. Stöhrer, of Leipsic, has considerably improved the carbon battery. Fig. 16 gives a view of such an element.

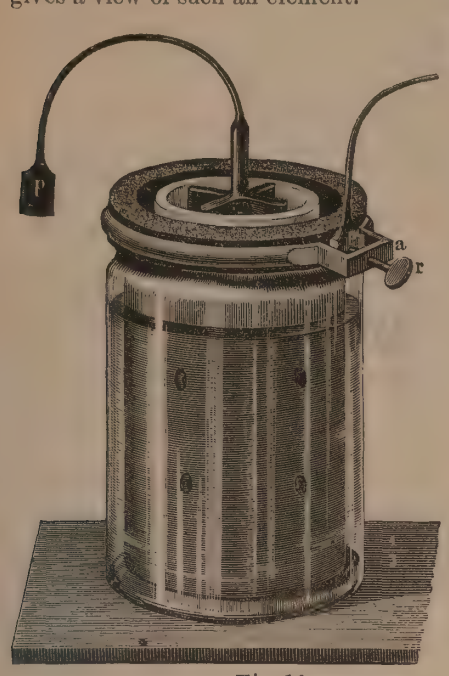


Fig. 16.

Fig. 17.

The cylinder, consisting of very solid and compact carbon, has on the top a projecting edge, which rests upon the edge of the glass vessel which surrounds the cylinder, and is provided with a heavy copper ring. This ring does not serve the purpose, as in those formerly constructed, of taking up the current from the carbon cylinder, but it is the mere bearer of a strip, *a*, in which is located a binding screw, *r*. Opposite to this screw the carbon lays bare, and at *p'* the curve is transformed into a plain surface, in order to present a flat contact to the connecting part of the nearest zinc. The zinc is crossed-shaped (a convenient form for casting), and should be properly amalgamated—that is to say, covered with quicksilver. It terminates in a round neck, in which the connecting wire is soldered.

The wire terminates in a heavy copper strip, *p*, which may be covered with platina on the side connected with the carbon cylinder between *p'* and *r'*.

The projecting edge of the carbon cylinder is soaked in wax, and the ring covered on the inside and outside and cemented with wax and resin, mixed in equal parts. As the plate *p*, covered with platina, takes up the current direct from the carbon, the main inconvenience of the former carbon batteries, namely, that the copper rings, which serve the purpose of taking up the current, oxidized very quickly, and then made very bad conductors, is obviated.

The Bunsen element develops, like the Grove, a very powerful current, but it has the great disadvantage, in common with the latter, that in using it there is evolved a heavy brown gas—peroxide of nitrogen—which is injurious both to the health and to the apparatus, and makes it unfit for general use.

Siemens-Halske zinc carbon element is represented in Fig. 17. *e* is the carbon cylinder, of 4½ inches high, 2⅛ inches inside and 3 inches outside diameter; *c* the porous clay cup, of 4½ inches high and 2 inches outside diameter; *d* the zinc cast in the ordinary cross shape, to which the copper wire *s* is soldered, which is to be connected with the carbon of the nearest element by means of clamp screw *f*. Around the upper part of the carbon cylinder a leaden ring about ¾ of an inch wide is laid, and around the latter a copper ring of the same width, which is separated and carries on both its ends flanges, which may be moved towards each other by means of a screw, and thus press the leaden ring closer to the carbon cylinder. The copper ring carries the prolongation *v*, on which clamp *f* is attached, by means of which the carbon cylinder is connected with the zinc of the nearest element. The entire system stands in glass *a*, whose form is to be seen from the drawing.

The solutions for this carbon battery for telegraphic purposes consist of sulphuric acid diluted with 15 to 20 parts of water, both for the porous cup holding the zinc, as also outside of them for the carbon cylinder. In both cases the zinc should be amalgamated very carefully.

A Bunsen battery of the latter kind, with diluted sulphuric acid in the zinc as well as copper cell, produces for some time a pretty constant current, if it is not kept closed too long, and, hence, it is very convenient for a telegraph line, which, when not in operation, leaves the battery open, and for working purposes requires only a momentary closing. If, however, they remain closed for some time, the carbon cylinder becomes coated with a layer of hydrogen which retards the conduction of the current in the inside of the battery, and even interrupts it.

In such cases the current of the battery is no longer constant. Even no open circuits its strength is soon exhausted, if it is kept in pretty constant action, by the rapid formation of sulphate of zinc. In Prussia, where these batteries were formerly in pretty general use for working telegraph lines, they required to be renewed every five weeks. The carbon cylinders and the porous cups of the old elements require to be soaked in warm water to remove the salts with which they become impregnated.

The carbons for Bunsen's battery are made by a process invented by Bunsen. The fine dust of coke and caking coal is first put into a close iron mould of the shape required for the carbon and exposed to the heat of a furnace. When taken out the burned mass is porous and unfit for use, but by repeatedly soaking it in thick syrup or gas tar and reheating it, it at length acquires the necessary solidity and conducting power. The carbon that forms on the roof of gas retorts is harder and better than the carbon thus made, but it is difficult to work, and the supply of it is limited.

Faure's Carbon Battery.—In this battery an outer jar contains a solution of common salt and a zinc cylinder. Inside the zinc cylinder is the carbon pole, which is made in the form of a bottle, and is filled with concentrated nitric acid. This bottle is closed by a carbon stopper to prevent the escape of fumes, and performs the double function of porous pot and of carbon pole; the nitrous gas rises inside the bottle and increases the pressure, forcing the acid through the porous cell in sufficient quantity to keep up the action.

Chromic Acid Battery.—A modification of the Bunsen battery is in use, in which a solution of bi-chromate of potash and sulphuric acid takes the place of the nitric acid. This solution is made by dissolving one pound of bi-chromate of potash in ten pounds of hot water, and when cold adding five pounds of strong sulphuric acid. As this addition causes the solution to become warm, it must be allowed to cool before being used.

The zinc is placed in a saturated solution of common salt, which is made by adding salt to the required quantity of water until it ceases to dissolve any more.

The chlorine of the common salt unites with the zinc, forming chloride of zinc; while at the carbon electrode the sodium re-places hydrogen in sulphuric acid, forming sulphate of sodium. The nascent hydrogen reduces chromic acid (produced by the action of sulphuric acid on the bi-chromate of potash), so that sulphate of chromium is produced.

The Grenet Battery.—The single fluid bi-chromate of potash or Grenet battery (Fig. 18), is a very good form of an experimental battery where constancy of current is not required, as, for example, in the laboratory and mechanical workrooms. The cell is in the form of a bottle, and contains a mixture of 2 parts of bi-chromate of potash, dissolved in 20 parts of hot water and 1 part sulphuric acid. The top is provided with a brass frame, to which is fastened a wooden cover. To this cover are attached two carbon plates which permanently dip into the fluid; and between the carbon plates a zinc plate is suspended, which may be plunged into the fluid or withdrawn at pleasure. When the zinc is withdrawn, the action ceases. The battery gives a powerful current for a short time, but rapidly polarizes. The length of time during which the fluid will retain its power depends upon the use which is made of the battery. It is not suitable for continuous use; but in all cases where a powerful current is required for a brief period, it is a very desirable and economical apparatus.

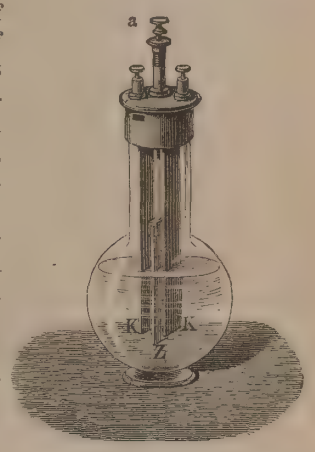


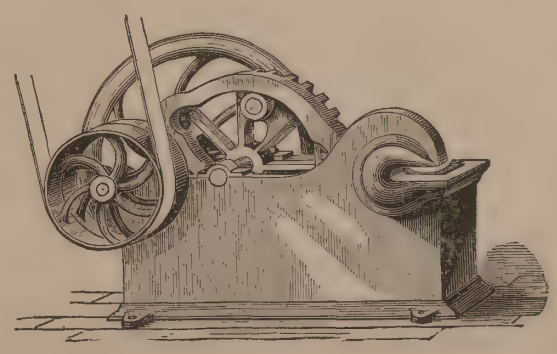
Fig. 18.

Electro-motive Force of the Various Elements.—The electro-motive force of a galvanic element is proportional to the intensity of chemical affinity, or the force tending to chemical action. The electro-motive force of each of the various sulphate of copper elements, described in former issues, is the same as that of the Daniell, 1.079 volts. The electro-motive forces of the several elements described in this chapter differ considerably from each other, although they are in all cases greater than in the combinations previously described. The electro-motive force of the Grove element, measured in volts, is 1.956; Bunsen's nitric acid, 1.964; Bunsen's chromic acid, 2.028; Faure's, 1.964; Grenet, 1.095.

SHEARS FOR CUTTING BAR IRON.

Our illustration shows one form in which the centre cutting principle invented by W. X. Stevens, of East Brookfield, Mass., as been applied for, which the following advantages are claimed:

It sets wholely above ground, occupies little room, and no special foundation is required. The blades are easily made, being fitted to hold by bolts and straps without any holes in the blades. The lever motion is positive. It is very strong where the



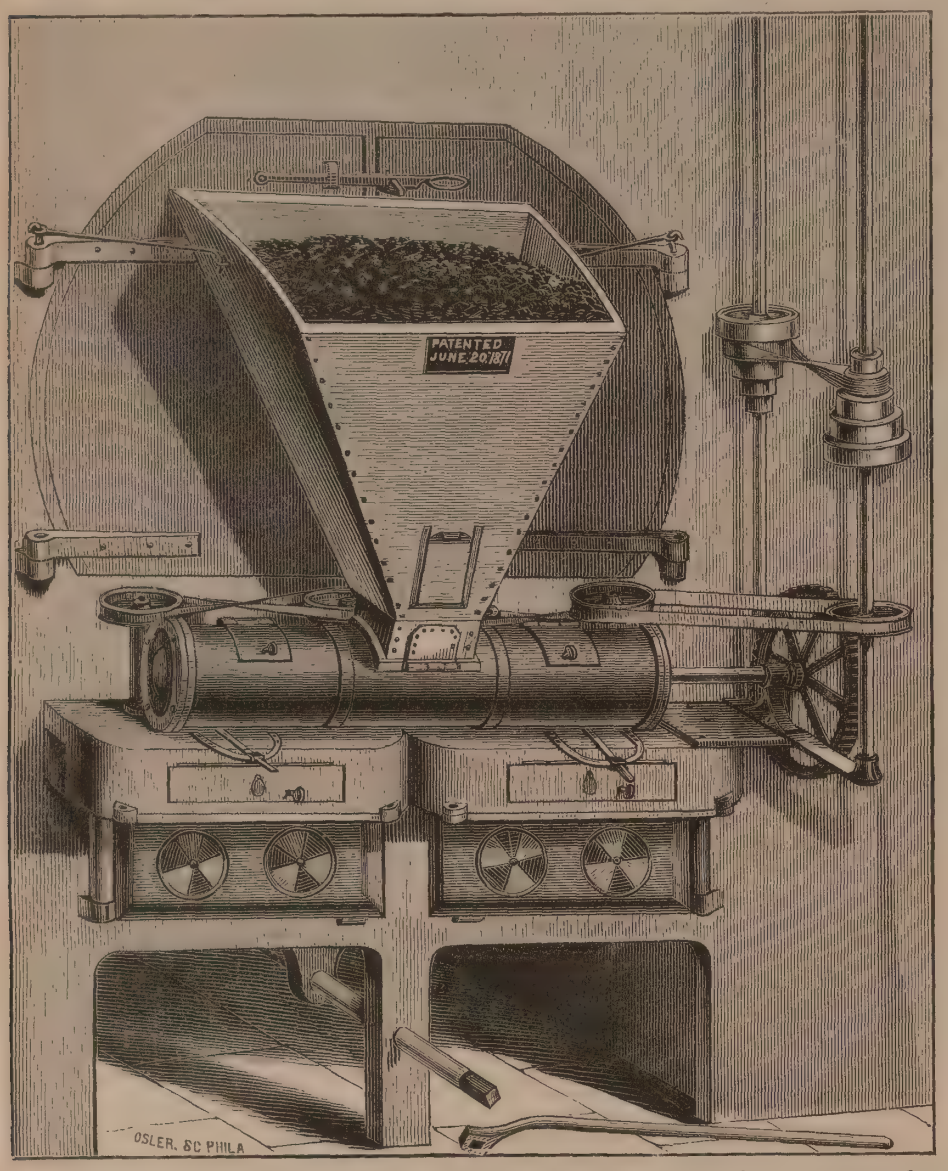
strain comes, yet is lighter than other shears. It cuts as fast as any shears, but requires less power to do the same work.

Shears for cutting old scrap and bar iron are probably subject to as rough work, and as badly abused even at that, as any piece of machinery. That they so often break down is no wonder, when we learn that shears which were recommended and purchased to cut iron rails, are frequently required (by accident) to cut old steel rails, and possibly these very rails were so hard that they broke in use on the road. This suddenly subjects the shears to four or five times the strain they are calculated for; but the maker claims that with these shears such an accident cannot do damage, for every part of the gearing has been so studied and proportioned that the heavy fly-wheel has been brought to a dead halt on work without damage anywhere. The manufacturers have lately designed a new form of this shear which has the joint wholly above and out of the way of scale and dirt, and has the usual quick down stroke, to accommodate the habits of rolling-mill men. That the principle of increasing leverage by placing the piece to be cut as near the centre as practicable is advantageous, there is little room to doubt. The blades and jaws of the shears have to hold the whole pressure however shaped, and should be strong, with large bearings to distribute the strain. But the running gear has one-half its load and strain removed very time you place the piece to be cut one-half as far from centre.

J. C.

ECONOMY IN COMBUSTION.

The questions of economy in steam engineering practice are far from being new in the minds of those most interested; and in this discussion the POLYTECHNIC REVIEW has been by no means negligent; and it is our intention to give to these problems increased attention and the most careful consideration. At the present day, when the turbine has excelled seven-fold the performances of the best steam boiler and engine, we can well see that there is greater room for improvement in increasing the 12 per cent. duty rating of the latter than the 85 per cent. of the former.



Between the boiler and the engine there is much loss, and by far the greater share of wastefulness is chargeable to the boiler. In the first place, comparing to the human system, the furnace is too choice in its appetite; the construction (which corresponds to chymifaction and chylifaction) is too imperfect; and the heating surfaces, like inactive mesenteries, do not absorb the virtue of what passes over them, but suffer too much to pass out unused through the chimney, like undigested food from the body.

It is evident that our reform must commence with the ordinary furnace; because its choice appe tite will not permit it to use fine fuel, millions of tons of coal dust are wasted annually. As regards the thoroughness and regularity of the changes which the fuel undergoes, we are largely responsible, for our system of feeding, which does not permit with any size or quality of fuel, that steadiness of supply inseparable from steadiness of combustion. The heating surface question we will leave until another time. Give the existing boilers an improved combustion and the heating surfaces will prove quite satisfactory. At present each chimney is a Parrott gun, shooting the profits of manufacturing establishments skyward. If we were asked to point out the greatest leaks for the profits of any steam-using manufactory, we would without hesitation point to the chimneys.

There is no reason why fine fuel should not burn not only equally well with large, but much better; just as finely masticated food should digest better than bolted lumps. In gun powder it is necessary to have grains, to prevent too easly ignition, but yet give a forcible expulsion of gases; for rockets a slow and equable combustion is needed, and hence the material is "mealed." But very fine coal cannot be burned in a bed on a common grate because it would fall through; and if the grate be too fine it would not admit enough air for combustion; and furthermore a bed of any thickness would be impervious to uprising air, and the carbonic acid formed in the bottom of the layer would be robbed in the upper portion and be sent off as carbonic oxide; the reaction being at first $C+2O = CO_2$; and then $co_2+c = 2\,co$, requiring more air to be admitted above the grate, to effect thorough combustion, giving $2\,CO+2O = 2\,CO_2$ as should be; but unfortunately this completion of combustion, if it happens, *happens too late* for the heating surface to be benefitted thereby. The bed must be constantly added to, to avoid too great alterations, and constantly sliced to keep it open and to remove ashes. These operations chill the furnace by admitting cold air in excess; and this not only disturbs the steam generation but injures the boiler by sudden contraction and expansion: furthermore hand stoking is costly.

What would we say of a fireman who would be constantly opening wide and shutting close his chimney-damper? What ought we to say of a fireman who fed fuel and air intermittingly?

We have recently noticed the operation of a device which has for its objects (1) the burning of small fuel as an economical substitute for large (2) regular and steady fuel supply (3) regular and steady air supply (4) equal distribution of fuel over the grate (5) abolition of the necessity of opening the fire door (6) cheapening the cost and abolishing the discomforts of stoking (7) abolition of the smoke nuisance, which in such cities as Wheeling and Pittsburgh is a serious and intolerable evil.

This device has been perfected through the efforts of Mr. Dillwyn Smith, aided by the best engineering experience that could be obtained in England, where the stoker has been most successfully introduced; there being now over 1500 of them working on land boilers and some 20 ships fitted with them.

The apparatus inspected is in operation at the card factory of Messrs. A. M. Collins, Son & Co., Third and Canal Sts., Philadelphia. This Automatic Stoker,* seen in the cut, is thus described:

The entire upper part of the stoker apparatus consists of a hopper for the reception of coals; connected with the lower portion of which there is a revolving crusher, which, after having crushed the coal into the requisite size, if not already small enough, drops it equally on two discs, revolving in opposite directions, and enclosed in a box with an aperture toward the furnace. The discs are furnished with fans or beaters, which throw the fuel into the furnace, spreading it equally all over the bars. The feed is regulated to supply the exact quantity required through the adjustment of the crusher. Special fire-doors, constructed on the most approved principles, for the admittance of the exact quantity of air required, are also supplied. For the purpose of keeping the fire clean and constantly removing the clinkers, an arrangement of rocking fire bars is used, by the occasional moving of which the fireman is enabled to keep his fires constantly bright, and in the best possible condition. The stokers enable firemen to run with three-inch fires instead of from five to eight inches in hand firing.

The entire apparatus is contained in a very small area, is easily repaired when necessary, and does not seem liable to be injured by the heat, all of its parts being entirely outside the furnace. A very small donkey engine is sufficient to drive the whole machine where it is not convenient to connect it with a shaft from the engine.

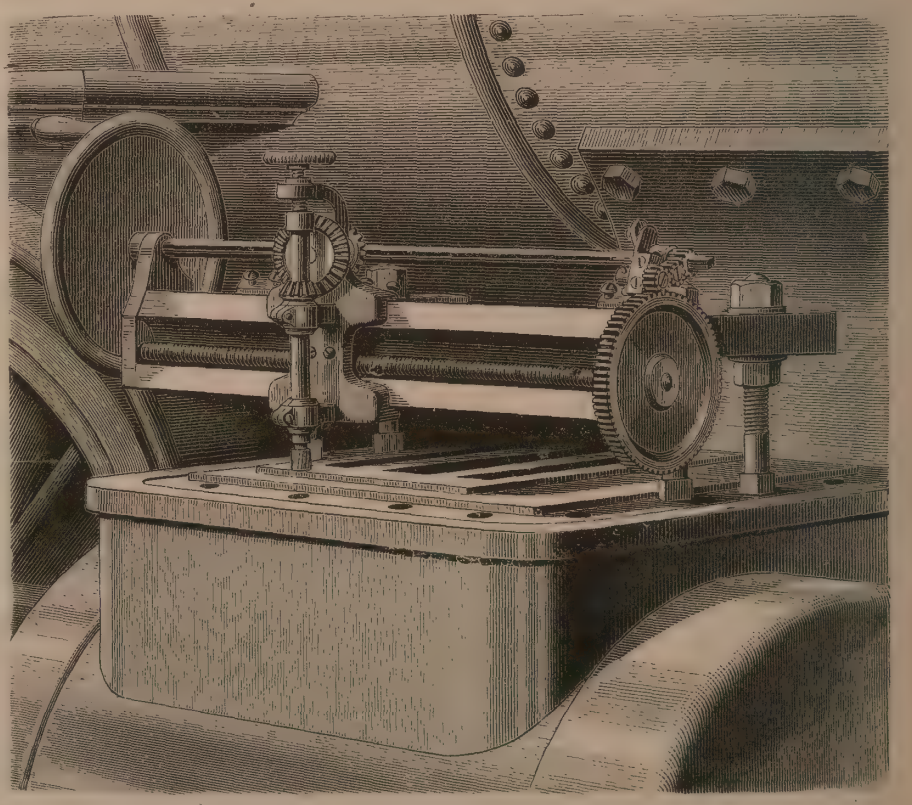
It will thus be seen that coal is supplied and distributed equally all over the furnace without opening the door, and that with the judicious arrangement of the latter, and the moveable grate bars, an almost perfect combustion must take place. This is shown in part by the greatly diminished amount of dirt or ash to be removed, and of smoke produced (concerning which, one firm reports the quantity of ashes, &c., to be about one half that with hand firing, and the smoke to be almost imperceptible). The patentees claim (and their claims seem borne out by our personal inspection and by numerous reliable certificates) a primary saving of about 20 per cent. in weight of fuel for a given amount of steam, and an equal increase in steaming capacity; and the additional saving in cost of stock over large coal is in some quarters about 50 per cent.

On shipboard, the mechanical stoker, while firing more cheaply than handwork, does away with the intense discomforts of the boiler regions, and it seems well adapted towards solving some of the important problems in steam-engineering economy. G.

*Built by the U. S. Automatic Stoker Co., No, 2 Chestnut St.; Philadelphia.

IMPROVED STEAM CHEST SEAT MILLING MACHINE.

Those acquainted with locomotive repairing know that the action of the heat in the steam causes the acid in the lubricating tallow to corrode the iron. This is especially noticeable as occuring in the vicinity of the valves and steam chest. In the latter case, the ledge which supports the steam chest is frequently corroded to such an extent as to require repair. To do this necessitates much time and labor, as a recess or groove has to be cut with the chisel; and then brass strips are driven in and trued up to effect a tight joint.



The object of the invention illustrated in the annexed engraving is to accomplish this work of grooving, then of trueing off the inserted pieces, without skilled labor and in a short time. The machine is supported by four studs, as shown; and motion is imparted to the mill or cutter by a shaft on which slides a suitable gear, meshing into one on the tool carrier or crosshead, the latter being fed to the work, in either direction, by a screw and suitable gearing, shown on the end of the machine. The tool, in starting, is fed down by the small hand-wheel on top of the carrier. Motion is given by turning the crank; and when it is desired to feed in an opposite direction, the small gears are disengaged by moving the small lever and swivel to which they are attached. The machine is also used to cut out the ports on new work; and by replacing the cutter with a drill, holes can be bored for the studs.

This invention has, we are informed, been successfully used in the shops of the Pennsylvania Railroad at Altoona. A. H. Campbell, Box 1136, Altoona, Pa., is the inventor and patentee.—*Sc. Am.*, xxii, 322.

THE MANUFACTURE OF MARBLEIZED SLATE MANTELS.

The manufacture and use of marbleized slate for many purposes—the most important of which is for mantel pieces—has reached such a magnitude as to warrant description at our hands, even were the process less interesting to note.

We have accordingly availed ourselves of the courtesy of one of the leading houses in this line, in obtaining information on the subject, from personal inspection of the works and the work there going on.

The material chosen for ornamentation, in imitation of fancy marbles, is slate, which has the advantage of low cost, ease of sawing and working, and fine grain. The slate used at these works comes from Vermont by vessel, and is landed on the wharf of the works.

It is in slabs, about an inch thick, roughed to the sizes and shapes most used. The outlines are cut with a band saw. Marble is inferior for "marbleizing," because of its cost and its coarser grain; the grain of slate running in planes parallel with the flat surfaces while marble is open and porous, and requires more coats of pigment. Rubbing and smoothing are performed on a horizontal cast iron wheel, about 10 ft. in diameter, running about 57 revolutions per minute. For marble, coarse grit sand is used; for slate a very fine grit.

The wheel at the works in question, has been worn down from 2½ inches, to less than ⅞ in. in thickness. After smoothing, any channels that are to be made, are cut with a rotary diamond cutter, the bit being hollow and rotating about 5,000 times per minute; a stream of water passing through it preventing injury to the diamonds.

The diamonds are set by Mr. Chabot, in the mode illustrated in our issue of June 23rd, 1877. The channel in a "half front" is cut in about three minutes; by hand, it would take one man an hour. The arm carrying the bit is heavily weighted, to ease the operator and cause greater steadiness of cut. Channels having acute angles, or sunken bevels, must be cut by hand, as must some irregular designs. The inner curve of the front is worked to a true line, if a fireboard is to be set in, otherwise, the frame of the heater will cover any trifling irregularity. The slab being worked to the required outline and surface, is now ready for marbleizing. The "ground" is mineral color, ground in copal varnish, because this is a quick dryer. The ground is generally black or brown. When dry, it is ready for the veining or pattern. Upon the surface of a tank of water, various colors mixed in oil are spread in peculiar characteristic patterns, these varying according as the color is ground, dropped, or sprinkled on, and stirred, fanned or otherwise mingled and intertangled. The colors do not blend. A slab being dipped edgewise in the water, is brought up so that the variegated film adheres to its surface, making the "marble pattern."

The marbled slabs are put in a steam kiln and kept at from 185° to 210° F. for twelve hours, baking the colors thoroughly. They are next coated with copal varnish, and again kiln-dried; then rubbed down with pumice-stone powder, again varnished and dried, and then rubbed with the finest polishing powder, and then with the hand; when they have a high, rich lustre, and are ready to be shipped or to be put together by clamps, &c., in place. There are about nine "standard" marbles which are imitated; about six or seven occasionally selected, and about six or eight odd patterns very rarely called for. Mexican onyx has, as yet, baffled even the imitative skill of Mr. Chas. E. Williams, who seems to have devoted himself, with peculiar enthusiasm and intelligence, to reproducing the appearance of the natural stones. From this gentleman we learn that the "Tennessee" marble is the hardest to imitate, and the Sienna the next. These are not done by dipping, as they are not "veined" patterns, but are produced by hand work somewhat as follows:

To imitate "Tennessee" the slab is grounded in a reddish brown color mixed in copal varnish; this color is dry in half an hour and is then spotted with the same color, made lighter with white or darker with burnt umber until it is covered with spots, which sink into the ground color and present a somewhat blurred appearance. When this is perfectly dry (which will be next day), take white paint mixed in water, and coat the slab with it, take a sponge and soak up some of the paint, the balance will be in small white spots as in the natural marble. The blurred appearance underneath will look like various stones thrown and mixed together.

To imitate "Red Pyrennese" the slab is grounded in varnish and color, as for dipping, but instead of oil colors, water colors are used. For one peculiar pattern, the slab is (after black "ground) coated with brown water color, which is next partly removed, by touching with a handful of thin muslin strips. These absorb the color, and leave bare places of peculiar outline. White color is then dripped on with a sponge, and runs on the cleaned places only; giving a pattern which could not be obtained by dipping, or in any other way. The use of water-colors gives a peculiar pearly or transparent effect, needed in the imitation of conglomerate stones, and by it, Mr. Williams hopes to imitate even the now inimitable Mexican onyx, which our readers will remember at the Centennial.

Where there are "panels" to represent various marbles on one slab, they are separated by cut lines, which are either filled with gold size, or otherwise used to act as boundaries. The veining of one stone should not appear continuous in an adjacent panel representing another kind of stone; this is a common fault, and is in part remedied by leaving a wide unveined band or channel between the panels. Where there is a small veined panel, or a series of such, on a plain black ground, the panels are first colored by dipping or hand work, and the surrounding surface is colored with a brush.

If the general surface is veined, the panels are first made, and then covered with paper, the whole slab is then dipped, and the panels are protected by the paper. We should mention that an expert "dipper" will prepare the films and dip 400 square feet of slate (about 150 slabs) in five hours.

The establishment visited is a large one, turning out with about 65 hands, aided by part of the force of a 25 H. P. Steam Engine, about ninety mantels per week. It is pleasant to find manufacturers working under what was five years ago a "secret process," so freely explaining all the "wrinkles" and secrets by which they have achieved such marked success. G.

FOR TRANSPORTING OR STORING EXPLOSIVES, Herr Gossie, of Antwerp, constructs, respectively, either in a railway car or in the earth, a water-tight reservoir, divided by means of T and angle irons into compartments of equal capacity, in which the combustibles (suitably packed in water-tight boxes) are placed after the reservoir is filled with water.—*D. Ind. Ztg.*, 1877, 398.

MACHINE KINEMATICS.

PART I.

About two years ago, there appeared in Germany, a book bearing the above title, and written by Prof. F. Reuleaux, Director of the Royal College of Engineering, at Berlin. The author was the president of the German Commission and jurors at our late Centennial Exposition, and is known as such to many Americans. His "Machine Kinematics"* came next to what Willis called the *Science of Pure Mechanism*, and Rankine the *Geometry of Machines.*

The book is so full of methods and views both novel and original, that the sensation which it created in Europe, was none but just. In less than two years, "the Kinematics of Machinery" was published in three languages beside the original German; in French, Italian and English; and there are few scientific books which met, when appearing, as much opposition, and as many friends.

When describing machinery, the authors of old took every machine as a whole; a mill was for them a mill, and all that they could do, in order to give an idea thereof to their readers, was to enumerate and describe, for itself every part and piece of the mill. It was a marked progress to decompose and analyze machines into certain combinations of parts, called mechanisms, as we do now; but Reuleaux went further; his fundamental principle is to decompose and analyze mechanisms into their *elements*. Every contrivance deserving the name of machine, has, for every one of its parts, but one definite motion relatively to the other parts; "dead points," where the parts can move in more than one direction, are defects in any kind of machine. The motion in mechanism is determined by the geometrical forms of certain parts called *elements*. They are always in pairs, the one enclosing the other.

In practical engineering, only pairs, *perfectly* enclosing each other, called *lower* pairs, are generally used, they are:

1. The twisting pair, (Screw and Nut).
2. The turning " (Pin and Eye).
3. The sliding " (Solid and Hollow Prism)

The lower pairs present, in their use, many advantages over the higher ones. All points in them describe similar curves; every point of a moving nut describes a helix, every point of a pin a circle, etc. Another advantage is, that by making one or the other element constituting the pair, respectively fixed or moveable, the motion obtained by the pair, rectilinear, circular or helical, remains the same. Such an exchange of one element for the other, in the same pair, Reuleaux calls an inversion. For example, the application of a screw with a head is the inversion of a screw with a nut. In the latter case, the screw is fixed relatively to the surrounding space and the nut moves, in the former, the nut (which may be a solid casting for example) is fixed. Condie's and Nasmyth's steam hammers are mainly a sliding pair, (solid and hollow prism) the one has the hollow cylinder fixed and the other the full one; Nasmyth gives a reciprocating motion to his piston, Condie gives it to the cylinder. Another interesting case of inversion is the Humphrey Tennant reversing link compared with Stephenson's, as shown by *Figs.* 1 and 2.

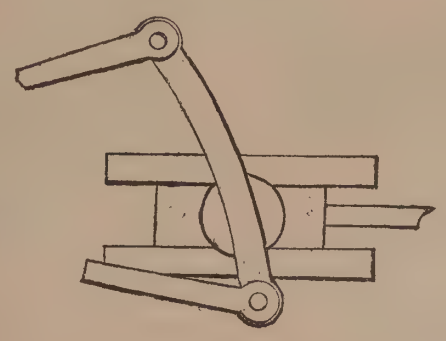


Fig. 1.

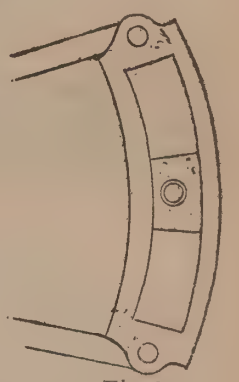


Fig. 2.

A case like this fully shows of what value the familiar and easy realization of the invertibility of solid and hollow prisms can be, and, in general, of all lower pairs.

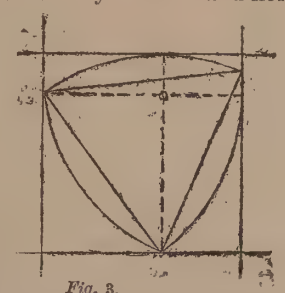


Fig. 3.

As for the higher pairs Fig. 3 will furnish us an example. A solid curve triangle moves in a hollow square and being at any moment in contact with the latter at four, its motions will always be definite ones like in the lower pairs; nevertheless every point will describe another curve, and beside, the inversion of a pair like this cannot take place without totally altering the absolute motion obtained.

Fig. 4 shows this mechanism as applied by Hornblower for driving the slide valves of steam engines.

Two elements originally joined together by *a body of whatever Shape or material* form what Reuleaux calls a *Kinematic link*, a combination of such links gives a *Kinematic chain* and all that has to be done to obtain a *mechanism* is to fix (relatively to the surrounding space) one of the links. Such are the main principles to be observed in analyzing machines as given in Reuleaux's book.

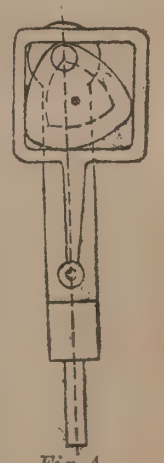


Fig. 4.

If now we take a Kinematic chain of 4 links for example we are at liberty to choose between them, the one link to be fixed in order to obtain a mechanism, and it is clear that a chain of 4 links can be altered into 4 different mechanisms by fixing (one after the other) each of the four links. It will be seen at once that the number of mechanisms to be dealt with in machine Kinematics will be very great, and that instead of giving every new mechanism a name to represent it, it might be advantageous to represent mechanisms by a kind of notation, similar to that used in chemistry and mathematics, expressing by formulæ, 1st, how the mechanism is formed, 2d, of what parts it is composed, and out of what Kinematic chain it originated. Such a notation has been devised by Reuleaux, and before illustrating by example the analysis of mechanisms, it will be profitable to give a part of his method of expressing by signs the action of machinery. The *names* of Kinematic elements are expressed like those of chemical elements, by Roman capital letters: S=Screw, P=Prism, C=Cylinder, Z=Tooth†, V=Vessel.

*The word Kinematics means Science of Motion (Kinema), and was first formed by the Frenchman Ampere.

†From the German "Zahn."

The form of elements is expressed by the following form-symbols affixed to the name symbols: + for solid bodies, ° for plane bodies, — for hollow bodies, ∽ for bodies with curved profiles.

For example C+ is a solid cylinder, like a cylindrical piston, a pin, etc.

C— is a hollow cylinder, a bearing etc. S+ and S— express a Screw and a Nut. $C_{\sim}$ a cylinder of curvilinear section. V— meaning a vessel of any kind, we can use V+ as the reciprocal of the vessel, for example a piston moving somehow in a box or cylinder V—. Small letters similar to those of the Name Symbols can be used as *Form Symbols:*

C_z^+ a cylindrical spurwheel, Pz a prism with teeth, or rack C_z^- an annular wheel.

A third class of symbols are those expressing the *relations* of one element in a Kinematic chain to another. The most important are the signs expressing the pairing and linkage of elements.

The first is expressed by a comma; C, C can stand for a pair of friction wheels working together; C+, C+ expresses that both are solid; C+, C— that one is annular or hollow.

The comma always indicates the possibility and existance of correct pairing, thus C—, C— is incorrect, as two hollow cylinders cannot be paired and C+, C+ shows at once that the axes of both C+, are parallel; otherwise correct pairing would be impossible.

Linkage is denoted by dots; C+. . . . C— is a link consisting of two cylinders, one solid, the other hollow, originally joined together; C—. . . . C— a link connecting two open cylinders or eyes (for example a connecting rod). The fixing of a link is indicated by underlining the dots between two elements P+. . . . . C+ a fixed link connecting a full prism and a full cylinder.

A number of other signs are partly the same as in arithmetic, and partly based upon them: =Equal, < greater than; > less than; ∞ infinite, | co-axial (having the same axis), ∥ parallel, ∠ oblique, ⊥ normal, † crossed at right angles, etc. The relations expressed by these signs may exist between either elements or links.

In the former case the comma between the elements is omitted, and the symbol itself is printed in smaller type than in the latter.

The three lower pairs will then have for symbols

S=S— C=C— P=P—

Symbols of relation between the elements of a link are placed in the dotted line

C+ . . . . . ∥ . . . C+ stands for the linkage of two solid cylinders which are parallel.

C_z . . . | . . . C+ is a spur-wheel rigidly connected with its co-axial shaft.

C_z^+ . . . | . . . . C— a spur wheel with a co-axial bored out boss.

If now we attempt to write down a complete Kinematic chain we see at once the impossibility of representing the *returning into itself* of the chain, as it would be inconvenient to write formulæ in a circle. An illustration will make this clearer. Let us write down the chain shown in Fig. 5. The cylindric elements are indicated in the figure by letters b, c, d, e, etc., and for the sake of distinctness we may in the first case add these to the symbols. Beginning at the link b c we have

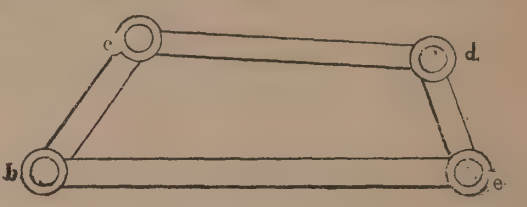


Fig. 5.

$$\underbrace{C^+ . . .\|. . . C^+}_{bc} = \underbrace{C^- . . \| . . . C^-}_{cd} = \underbrace{C^+ . . .\|. . . C^+}_{de} = \underbrace{C^- . . .\|. . . C^-}_{eb}$$

If be is the link fixed we will write the mechanism.

$$C^+ . . .\|. . . C^+ = C^- . . .\|. . . C^- = C^+ . . .\|. . . C^+ = C^- . . .\|. . . C^-$$

It may appear strange that this formula does not show any difference in form between the links, but this is no defect as it has been previously shown that the inversion of lower pairs (or of the form symbols + and —) has no influence whatever on a mechanism and its motion. The links appear not only alike in the formula, but they *are in their actual nature really alike.*

In many cases the symbolic description of a chain may be greatly shortened, especially after the analysis of the chain and links has been completed and can be assumed to be known. Lower pairs and some others may be expressed by one letter, if both the partner elements have the same Name Symbol. The distinguishing mark for such contractions is a parenthesis.

(S) Twisting pair S=S—
(C) Turning " C+=C—
(P) Sliding " P+=P—

(C_z) a pair of spur wheels and so on. This allows us to write Fig. 5.

C . . .|| . . . (C) . . .|| . . . (C) . . .|| . . . (C) . . .|| . . . C—

Only the first and the last element require to be written separately with their Form Symbols. The one letter in the parenthesis representing a turning pair. In cases where the same relations (in Fig. 5. parallelism) exist beween all the links forming elements, we can go further.

Without making its meaning uncertain we can condense the formula for Fig. 5 into (C_4∥) in words "C parallel 4" or "C four parallel" and meaning a chain formed by four parallel turning pairs of elements and 4 links, each connecting two of the elements.

S.

(To be continued.)

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SLIDE VALVE GEARS.

By Hugo Bilgram, M. E.

Part III.

The Meyer Cut-Off Gear.

The described mechanism for changing the lap of the cut-off valve is not readily accessible for inspection, and being exposed to a high temperature is apt to wear out in a short time. This gave rise to the invention of other modes of changing this lap. One of these is shown in Fig. 68. The eccentric rod is joined,

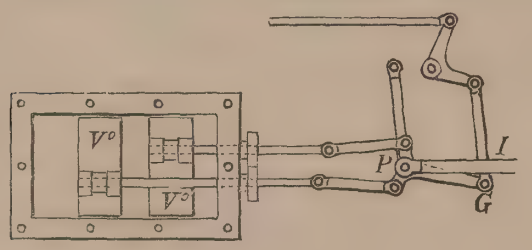

Fig. 68.

at P, to the centre of a yoke, from the ends of which the two cut-off plates $V°, V°$ are operated. A raising or lowering of the arm PG of the yoke will change the relative position of the cut-off plates. The objectionable feature of this arrangement is the one-sided action of forces, the valve stems being out of centre with the cut-off plates.

Another modification is known as the "Rider Cut-off." The passages of the main valve have an inclined position, converging towards one side. The ends of the cut-off valve, whose seat on the main valve is cylindrical, are also inclined to conform with the passages of the main valve. A partial rotation of the cut-off valve, by its stem, will bring its wider or narrower side over the passages, and thus change the lap.

There are quite a number of other devices for the same purpose, but their descriptions would occupy too much space.

Problem XII.—It is required to construct a Meyer valve gear for an engine of 20″ stroke, the admission of steam to range between 1″ and 16″ follow. The rapidity of the cutting off at both extreme grades is to be equal to one-half of that of the main valve at the moment it closes the steam-port. The width of the steam-port is $\frac{7}{8}$″, and the greatest port-opening is to be equal to this width. The lead is to be $\frac{1}{16}$″, the release is to take place 1″ before the end of the stroke, and the cushioning is to begin as early as the case will admit.

To solve this problem we first draw the diagram for the main valve with a greatest port-opening=$\frac{7}{8}$″, lead=$\frac{1}{16}$ and release=1″ (see Fig. 69). In order to comply with the condition mentioned last, the main eccentric should have as much angular advance as possible, hence we make it to cut off at 16″. Next we draw the crank angle $OE°$ for 1″ of the stroke, which is the earliest point of cut-off required. The centre $Q°$ should be located in a line bisecting the angle $E°OE$, and to get its exact location we must consider that the line OK (K being the point of contact of the line OE with the lap circle L) represents the rapidity of the cutting off by the main valve, and in order to comply with the required condition, the point $K°$, bisecting the distance OK, should be the point of contact of the line OE, and the greatest lap-circle of the cut-off diagram.

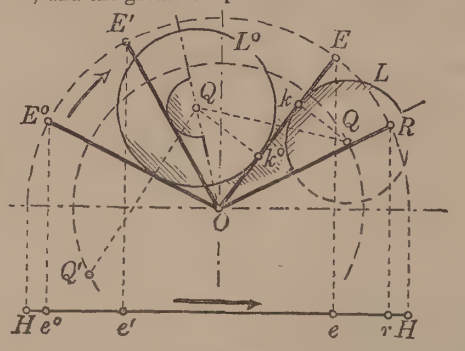

Fig. 69.

We find accordingly the point $Q°$ by drawing a line from $k°$ at right angles to OE. The sought throw of the cut-off eccentric is equal to the distance $Q'Q°$, and the angle formed by bo h eccentrics is equal to the angle $Q°Q'O$ of the diagram; (or if we choose to cut off with the inside edges of the cut-off plates, the line $QQ°$ and the angle $Q°QO$ are to be taken instead, and the eccentric located like the boint $i°$ of Fig. 59).

By the diagram we find, for the main valve, a travel of 3″ full, a lap $\frac{5}{8}$″ full, the inside lap is equal $\frac{1}{16}$″, and for the cut-off eccentric we obtain a throw, $Q'Q°=2$″ full. The greatest laps, both positive and negative, of the cut-off valve are $1\frac{3}{16}$″ full, and the relative travel of the cut-off valve over the main valve=2 $OQ°=2\frac{1}{8}$″ full.

Since the change of lap must be accomplished on both cut-off plates, their total adjustment must amount to four times the greatest lap, which is more than $3\frac{1}{4}$″. Attention must also be paid to prevent the *inner edges* of the cut-off plates from opening the passages of the main valve before the latter closes the steam ports of the cylinder. The danger for this occurrence is greatest when the cut-off plates are fartherest apart, having a lap=$1\frac{3}{16}$″, and since the main valve closes the port at E when the relative movement of the cut-off valve is equal to $Q°K°=1\frac{3}{16}$″ full, the apprehended opening can be prevented by an overlapping of $1\frac{3}{16}$″ plus $\frac{1}{4}$″ for seal. Hence the width of each cut-off plate must be made equal to this figure ($1\frac{1}{16}$″) plus the width of the passage of the main valve, $\frac{7}{8}$″ plus the lap, $1\frac{3}{16}$″ full=$3\frac{3}{4}$″ full, and their dimension, out to out, when spread apart, will be about $8\frac{1}{8}$″; and since farther the absolute travel of this valve is 4″ full, the valve chest is required to have a length, inside clear, of about $13\frac{1}{2}$″, allowing about $\frac{1}{4}$″ clearanceon each side.

By altering the diagram, with a view of doubling the rapidity of the cutting off, the valve chest will be found to require a clear inside length of about $21\frac{1}{2}$″, and the valve and the cut-off plates would assume rather impracticable dimensions.

If it is desired to know the relative position of the cut-off plates, *i.e.*, their laps, for any grade, say when cutting off at quarter stroke, we simply draw the corresponding crank angle, OE', and from $Q°$, tangential to this line, the lap circle, the radius of which is the sought lap which in this instance is positive. If the crank angle of the given grade were beyond $OQ°$ the indicated lap would, of course, be negative.

When used in connection with a link-motion, the relative movement of the cut-off valve changes with the grade of the link. While the grade of the link is changed, the point $Q°$, Fig. 70 (compare with Fig. 67) will move exactly as the point

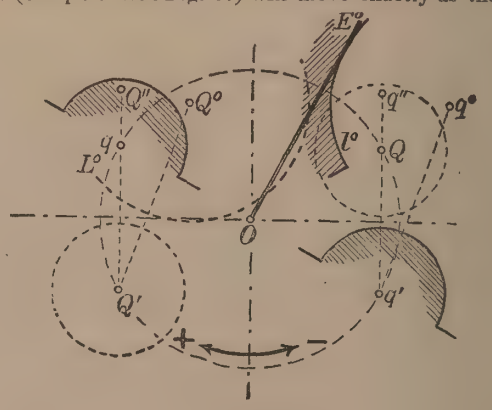

Fig. 70.

Q' does, because the line $Q'Q°$ represents the cut-off eccentric, which remains undisturbed as the link is reversed. The link is, however, generally used at the full stroke grades only, and the diagram, Fig. 70, shows these two grades, capital letters standing for the forward and small letters for the backward rotation. We might have considered the diagram of eccentrics for both grades separately, when we would have obtained the same diagram. Now we see that the range of the cut-off for the backward rotation is limited, the latest cut-off being at $OE°$. This condition can be improved by advancing the cut off eccentric more or less; and the relation between the forward and backward grades will be entirely equalized if the angle of advance of the cut-off eccentric is made=90° when the points $Q°$ and $q°$ will be removed to Q'' and q'', vertically above Q' and q' at a distance equal to the throw of the cut-off eccentric. It will then be necessary that the greatest negative lap, for the latest cut-off, should exceed the positive lap for the earliest cut-off, as will be seen by drawing the respective lap circles.

A rectification of the cut off can be accomplished in a similar way as with the Gonzenbach valve, and this discussion need not be repeated again. However, with the mechanism shown in Fig. 68, the rectification can be made to cover more than two grades by making the yoke out of straight, as shown in the cut. The effect of this expedient is equivalent to a lengthening of the valve stem as the point of cut-off approaches half-stroke, and *vise versa.*

To be Continued.

COLD-PUNCHED *vs.* HOT-PRESSED NUTS.

Results of a Series of Tests of Cold-Punched and Hot-Pressed Nuts at the Mechanical Laboratory, Stevens Institute of Technology, Hoboken, N. J.

BY PROF. R. H. THURSTON, DIRECTOR.

MECHANICAL LABORATORY, DEPT. OF ENGINEERING,
STEVENS INSTITUTE OF TECHNOLOGY,
HOBOKEN, N. J., Aug. 21, 1877.

The following are the results of a determination in the Mechanical Laboratory at the Stevens Institute of Technology, of the resistance to stripping and to bursting of several sets of hot-pressed and of cold-punched nuts. They were of four sizes, viz.: ½ in., ⅝ in., ¾ in. and ⅞ in. The hot-pressed nuts were made by Mr. J. H. Sternbergh, of Reading, Pa., and the cold-punched by Messrs. Hoopes & Townsend, of Philadelphia.

The conditions of the trial were:

First, that all the nuts to be tested be suitably marked and a record kept of the number and marks of each sort.

Second, that those for tapping be examined, to see that the sizes of holes are exactly alike and are the same sizes as agreed upon, viz.: Franklin Institute standard.

Third, that all nuts of a given size, which are to be tested by stripping the threads, be tapped with the taps furnished by Messrs. William Sellers & Co.

Fourth. Directions for the tests of the stripping of the threads of the nuts: Take 120 rods as follows: 30 of each ½ in., ⅝ in., ¾ in. and ⅞ in., full diameter, all to be 13 in. long; cut threads on each end one inch; first, however, turning down the fullness of the bar to exact diameter a distance of two inches on each end. These rods to be made of the best chrome steel, and nuts to fit closely as possible. The makers of the taps to furnish the rods, provided we have not the facilities for doing so.

Fifth, that the tapped nuts to be used on rods in preceding clause are to be trued up accurately on the side on which the punch entered the nut.

½ in. nuts turned down to 5-16 in. thick.
⅝ " " " ⅜ "
¾ " " " 7-16 "
⅞ " " " ½ "

Sixth, that a cold and hot-punched nut be placed on opposite ends of the same rod, with their finished sides facing each other, and submitted to a pulling strain in the testing machine with such clamps holding each nut as will secure a uniform strain on the face of each nut equidistant from the centre of the bolt; that the nut so arranged be drawn asunder, until the rods break or the thread in one or both of the nuts gives way. If the rods break before the nuts strip, then, in subsequent tests, the nuts are to be turned down on the side mentioned until they are thin enough to strip their threads without breaking the rod. Should one nut only strip the thread, then the remaining nut to be subjected to a strain by clamping the shank of the rod, and pulling on the remaining nut until it strips or breaks the rod.

Seventh, that a record be kept of the stripping, breaking or bursting strain in all cases.

Eighth. No rod or nut to be used a second time, except as stated in paragraph 6.

Ninth. In all cases the nuts are to be pulled in the direction in which they are punched, or *vice versa*, only both alike.

Tenth. A second test is to burst the blank nuts asunder by forcing them on a round conical mandrel, until they burst quite open; a record to be kept of the strain required to force the nut on the mandrel and the distance it travels from the point where the nut is first tight until it is found to be burst open.

Eleventh. The mandrels to be used for the test in paragraph 10 are to be made of cast steel, made large enough to enter the hole of the nut. The conical part to increase in diameter about 3-16 in. in six inches. The taper part to be polished smooth and oiled and wiped clean before each test.

Twelfth. The diameter of holes, thickness and outside short diameters of the nuts to be drifted, to be exactly the same.

Thirteenth. The three qualities of nuts made by each contestant to be tested in this manner by bursting both blank and tapped, say 12 of each, or a total of 72 blank and 72 tapped, making 144 in all.

Of each size, six sets of nuts were tested, viz.:

Hot-pressed nuts made expressly for the trial by J. H. Sternbergh from iron furnished by him. Hot-pressed nuts made expressly for the trial by J. H. Sternbergh from iron furnished by Hoopes & Townsend. Cold-punched nuts made expressly for the trial by Hoopes & Townsend from iron furnished by them. Cold-punched nuts made expressly for the trial by Hoopes & Townsend from iron furnished by J. H. Sternbergh. Hot-pressed nuts chosen at random from stock of J. H. Sternbergh. Cold-punched nuts chosen at random from stock of Hoopes & Townsend.

These nuts were received here in the form of blanks and in the condition in which they were left after punching. They were all hexagonal, and of the following dimensions.

	½ in.	⅝ in.	¾ in.	⅞ in.
Distance between parallel sides	0.885	1.069	1.254	1.45
Diameter of hole	0.3986	0.505	0.6105	0.726
Diameter of hole after tapping	0.4056	0.5143	0.623	0.733

TRIAL BY STRIPPING STRESS.

The nuts for this test were taken at random from the lots received, and were carefully tapped with a set of taps of Franklin Institute standard, made to order for the Mechanical Laboratory by Messrs. William Sellers & Co.

The same set of taps was used for both the hot-pressed and the cold-punched notes.

After tapping, the nuts were faced down to thicknesses which a preliminary series of experiments had shown to be, in each case, the thickness which would allow all the nuts to retain a resistance to stripping slightly less than the tensile resistance of the screwed rod on which they were placed when applying the load.

The following were the thicknesses:

For ½ in. bolt— ¼ in. thick.
" ⅝ " " — ⅜ " "
" ¾ " " — 5-16 " "
" ⅞ " " —13-32 " "

The nuts were faced on the bottom side only, *i. e.*, upon the side at which the punch entered, upon mandrels received from the manufacturers. Except in facing and tapping, no change was made in the dimensions of any part of the nut. After facing, the nuts were carefully paired off upon the screwed rods and tested in the manner described in Art. 6.

All of the nuts were tested with their faced sides in contact with the sleeve of the testing machine.

TRIAL BY BURSTING STRESS.

The tapped nuts used in this test were tapped with those used in the trial by stripping.

The blank nuts were chosen at random from the lots received. The nuts were faced to the following thicknesses, which were, in each case, the greatest obtainable from the thinnest nuts received.

Thickness of nuts tested for bursting stress:

½ in.—0.44 in. thick. | ¾ in.—0.72 in. thick.
⅝ in.—0.6 in. " | ⅞ in.—0.72 in. "

It was expected to use a thickness for the ⅞ in. nuts proportional to the thickness of the other sizes, but in consequence of one of the hot-pressed ⅞ in. lots being unusually thin, the thickness of all was made 0.72.

As in the case of the stripping trial, the nuts were faced on the bottom side only, and, except in this respect and by tapping, were not changed in dimensions. The tests were made in a Riehlé tension machine, in accordance with Art. 10 of the conditions of test.

The tests were conducted as follows: The mandrel was well coated with a lubricating compound of plumbago and grease, and the nut, with the faced-side down, slipped on until it came to a bearing.

After rupture, the mandrel, with the nut undisturbed upon it, was removed from the machine, and the distance that it traveled was recorded.

DISCUSSIONS OF RESULTS OF TRIAL.

From an examination of the tables it is seen:

(1). Out of 180 nuts tested by stripping stress, only one hot-pressed nut broke under a greater load than the cold-punched tested on the same rod.

(2). The average of the stripping or breaking resistance, and of the bursting resistance of any of the sets of cold-punched nuts is greater than that of any of the classes of hot-pressed nuts of the same size.

(3). In 9 out of the 12 lots tested by stripping, the minimum resistance of the cold-punched nuts exceeds the average resistance of the hot-pressed of the same size and class.

(4). In 21 out of the 24 lots tested by bursting stress, the minimum resistance of the cold-punched nuts exceeds the average resistance of the hot-pressed nuts of the same size and class; but in one instance it is less than the average and minimum of every other set and size.

(5). In five cases of stripping, the minimum resistance, of the cold-punched exceeded and in two equaled the maximum resistance of the hot-pressed of the same size and class.

(6). In 11 cases of bursting the minimum resistance of the cold-punched is greater than the maximum of the hot-pressed of the same size and class, but in one case the maximum resistance of the hot-pressed nut exceeded that of the cold-punched.

(7). The amount by which the average resistances to stripping and to bursting of the cold-punched exceeded those of the hot-pressed, varied irregularly with the size, but may be regarded as practically independent of the size for the range tested.

(8). For the same material the amount of the excess of the average resistance to stripping of the cold-punched over that of the hot-pressed varies from 14.6 to 25.1, and average 19.7 per cent. of the latter.

(9). The amount of this excess for the bursting test varies from 6 to 75.7 and averages 51.9 per cent. of the resistance of the hot-pressed for the blanks, and from 10 to 41.6 with an average of 24.3 per cent. for the tapped.

(10). With different irons the amount of the excess for stripping varies from 3.9 to 34.4 and averages 19.7 per cent. of the resistance of the hot-pressed nuts.

(11). With different irons the amount of the excess for bursting varies from 3 to 65 and and averages 48.4 per cent. for the blank, and from 2 to 33 with an average of 22.5 per cent. of the resistance of the hot-pressed for the tapped.

(12). For the same iron, the blank cold-punched nuts have from 22.3 to 35.1 per cent. of the ductility of the blank hot-pressed, and the tapped cold-punched from 52.7 to 79.6 per cent. of that of the tapped hot-pressed. With the different iron the ductility is from 22 to 35 per cent. greater in the blank hot-pressed and from 54.3 to 74.5 per cent, in the case of the tapped.

The same marked difference in the ductility was noticeable in the manner in which the nuts ruptured, the hot-pressed in both the stripping and bursting tests yielding very gradually, rupturing noiselessly, and sometimes allowing the mandrel to be pulled quite through them without rupture ensuing. They were seldom more than cracked by the stripping stress, while the cold-punched nuts gave way in the bursting test with an audible sound and in the stripping test they usually broke in two or more pieces with a loud report.

(13). In five sets of nuts tested by stripping, the uniformity of strength shown by the cold-punched is greater than that exhibited by the hot; in four cases the hot-pressed exceeded, and the two styles are about equal in the remaining three classes.

In eleven classes tested by bursting the cold-punching excels in uniformity, in four the hot-pressed are ahead, and in nine there is no difference between the two styles.

The greatest difference of strength occurs more frequently with the hot than with the cold, but the greatest individual case of differences occurred with cold-punched nuts.

The difference in uniformity is therefore slightly in favor of the cold-punched nuts, but the difference between the two kinds in this regard is not a prominent one.

The results of the trial, taken as a whole, are conclusive in proving:

First, that the cold-punched nuts possessed a much greater average strength, combined with greater rigidity and slightly greater uniformity than were exhibited by the hot-pressed nuts, and that the superiority was most strongly manifested in the trials by stripping stress.

Second, that the cold-punched nuts exhibited a strength never attained by the hot-pressed nuts, but that such variations in the strength of both styles occurred as to have caused the hot-pressed nuts to equal, and occasionally to excel, in strength the weakest specimens of cold-punched nuts.

Referring to the differences in the character of the iron of which the nuts were made and their respective values as materials for either hot or cold treatment, I can say but little, as the evidence of the results of the tests are not of a completely decisive character.

The following table gives the results of calculations made upon resistances of these nuts to stripping or breaking in order to ascertain their resistance to stripping in pounds per square inch of the sheared section of their threads:

Stripping or Breaking Resistance per square inch of Shearing Area.

MATERIAL		½ in.		⅝ in.		¾ in.		⅞ in.	
		Cold Punched....	Hot Pressed.....	Cold Punched....	Hot Pressed.....	Cold Punched....	Hot Pressed.....	Cold Punched....	Hot Pressed.....
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Stock Nuts . .	Maximum.....	43,908	39,387	46,159	36,937	41,238	36,776	40,939	40,411
	Minimum	34,234	29,322	36,988	25,544	37,319	29,345	31,063	30,149
	Average.....	39,351	34,394	41,489	32,600	39,101	32,732	38,259	32,834
Hoopes & Townsend iron.....	Maximum.....	44,541	35,711	45,699	36,605	43,460	35,115	39,507	33,398
	Minimum.....	26,459	23,977	38,700	30,006	38,011	29,450	33,402	27,525
	Average.....	37,739	31,299	41,063	33,691	40,956	33,561	36,847	31,304
J. H. Sternbergh iron...	Maximum.....	48,307	39,236	45,699	39,722	43,905	35,278	40,948	33,355
	Minimum.....	38,001	29,714	39,722	30,653	34,603	32,282	35,495	30,696
	Average.....	42,096	36,356	43,139	34,467	39,526	34,491	37,788	31,353

Nuts broke and stripped without regularity at all loads, and the average figures given may be assumed to be figures for the basis of calculation of strength on the assumption that the nut will rupture by shearing.

The results of the bursting tests are purely comparative, since the peculiar method of application of the bursting stress renders calculations based upon the results valueless. It is to the manner in which the taper mandrel distributed the stress and to differences in ductility that the several peculiarities noticeable in the results of the bursting test are attributable. Thus the greater strength of the tapped nuts compared with the blank is due to the fact that with the blank nuts only the upper edge of the hole in the nut was at first in contact with the mandrel, while the tapped nuts, by the crushing down of their threads, brought into bearing a larger surface, and thus, while the absolute resistance of a blank nut may be in excess of that of a tapped nut, by the amount of the extra metal it contains, it may not render available as much of its resisting section as a tapped nut.

It is proposed to supplement this statement of the results of tests of strength of nuts with a report on the cost, as determined by experiment, of finishing the two styles of nuts. This will, it is hoped, enable any one to arrive at a satisfactory determination of the true relative value to the consumer of hot-pressed and cold-punched nuts.

NOTE.—The full report, with the cuts showing the manner of testing, and the elaborate tables of details, being too long for publication in a periodical, will be published entire, with the report of the finishing test, in pamphlet form. Copies may be had upon application to Messrs. Hoopes & Townsend, Philadelphia, Pa.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

The Decomposition Theory of Steam Boiler Explosions.—At the recent meeting of the American Academy of Sciences, an apparatus was shown at work, which proved that steam might be decomposed by simple heat into the constituent gases of water—oxygen and hydrogen. The heat employed was a little over ordinary redness, but did not reach whiteness. This experiment is of the highest value, as illustrating a possible cause of boiler explosions. The apparatus was very simple—a flask in which water was heated, a tube conveying the steam into a closed platinum crucible, where it was again heated by a spirit lamp, and a tube thence carrying the superheated steam and the liberated gases to an ordinary pneumatic trough, where the mixed gases were collected in a test tube, while the steam was absorbed. At the conclusion of the experiment, the gases thus collected were exploded by a lighted match, showing beyond question that they were the components of water. The experiment indicates that this explosive mixture of gases may be formed in a steam boiler. But it can only result from the most culpable carelessness. The boiler must, at least in part, be raised to a full red heat. Then cold water must be injected, for so long as steam and the gases are mixed, the latter cannot explode. The injection of water must condense the steam in the boiler before it cools the red-hot iron. All these conditions being fulfilled an explosion of the gases may take place.

Evidences of a Lunar Atmosphere.—Professor Alexander brought forward at the last meeting of the Natural Academy of Sciences, a variety of evidence tending to indicate some envelope, like an atmosphere, for the moon. The evidence was principally drawn from observations during eclipses. The explanations usually offered for the bright band seen around the moon at such times were fully considered, and shown to be inadequate, though good as far as they would apply. The ruddy band of light is much too broad to be the sun's chromosphere. Various experiments proved that it was not a consequence of contrast alone. It was most apparent in those instances where the moon was nearest the earth. It could best be accounted for by supposing an atmosphere to the moon—a thin remnant of ancient nebulosity, comparable to that which accompanies the earth and gives rise to the appearance of the aurora borealis.—*N. Y. Tribune.*

Black Finish for Brass.—Make a strong solution of nitrate of silver in one dish and nitrate of copper. Mix the two together and plunge the brass into it. Now heat the brass evenly until the required degree of dead blackness is obtained. This is the method used by French instrument makers to produce the beautiful dead black color so much admired in optical instruments.—*American Manufacturer.*

Uses of Water Glass.—The uses of silicate of soda are more and more extending, notwithstanding that the business of its manufacture is still in its infancy. The greatest demand is for soap making. It is better than the addition of resin, and its alkalinity adds to the cleansing power. It retains water, keeps the soap from shrinking, and prevents great loss of weight. It can scarcely be called an adulteration. It is used as paint, and mixes with all mineral colors; there are even now factories which make paints of mixtures of oil-paints and water-glass. It makes the paint more durable, and gives it a gloss-like varnish. It is also indispensable as a mordant for calico-print works, and at present, therefore, extensively used as such. It makes an excellent fire-proof cement for stove and iron foundries, especially in putting up iron fronts for buildings. It is the main ingredient in several methods of making artificial stone. For instance, in the Ransome process, which in England consumes thousands of tons yearly. It makes an excellent adhesive mucilage, and is used in a cheap mixture to mend china, glass and wood. Being perfectly fire-proof, it will give its quality to wood or paper when this has been soaked in it; and being when dry also water and damp-proof, it is the best coating for brick vaults, and thus very valuable for beer brewers, sugar refiners, &c. These are not all the praiseworthy qualities of this valuable material.

ENGINEERING—CIVIL AND MECHANICAL, &c.

The New Railroad Bridge over the Kentucky River.—The new Southern Railroad from the city of Cincinnati to the Kentucky River has just been opened. At that river there is said to be the highest railroad bridge yet built. It is 275 feet above low water mark, having three spans, each 375 feet long, the total length being 1,125 feet. There is a bridge in Switzerland which is said to be 254 feet high, but with a span 144 feet long, and one at Varrugus in the Andes, 252 feet high, with spans 125 feet long. The piers of the Kentucky Bridge are the largest in the country, excepting those of the New York and Brooklyn Bridge, the stonework being 130 by 47 feet, and the base of the ironwork 117 by 28 feet. The frame is all wrought iron, and was built out from the abutments towards the centre of each span. The fastening of the junction points was accomplished in a novel way. One sunshiny day having expanded the framework, the connecting bolts were fastened, and so much secured; then a second day of sunshine having given all the expansion the bridge was capable of, the bolts were made fast permanently. At the opening the bridge was subjected to seven severe tests, and stood them all admirably. The ironwork of this bridge was manufactured by the Edgemoor Iron Company, of Wilmington, Del. The parts, it is said, went together like a Springfield musket. Mr. C. Shaler Smith designed the work, and the Baltimore Bridge Company executed it.—*Iron Age.*

Coal Cutting Machines in Scotland.—The benefits to be derived from the adoption of mechanical coal-cutters are the alleviation of the miner's work, and a minimum of production of small coal; the latter would be greatly to the advantage of colliery-owners, as small coal is especially in times of depression in the trade, almost unsaleable, and is always sold much below the value of large coal. It is noteworthy that so little success has attended the making of fuel from a combination of small coal with another binding material; this circumstance will go far to induce owners of collieries eventually to adopt coal cutters in order to make profitable disposal of their coal. The Gartsherrie coal-cutter has been introduced by the firm of Messrs. Wm. Baird & Company to meet these requirements; that is to make the percentage of large salable coal as great as possible, and to reduce the cost of production; the latter may be effected in various ways, by economy in labor, reduced area of workings in operation, and saving of timber, and by less amount of capital expended in workingmen's dwellings. In the Gartsherrie coal-cutter—as is well known—the cutters or picks are attached to an endless chain, which works round a jib extending to an undercut in the coal; the usual projection is 2 ft. 9 in. under the coal, but this can be made up to 5 ft. if required, and as so little depth is required for the jib, the undercut may be made so low as $2\frac{1}{2}$ in., which gives very small percentage of waste or small coal—varying, of course, with the heighth of seam. The machine is carried upon a sole plate of malleable iron 6 ft. by 3 ft. in width, resting on four wheels. Two 6-in. cylinders 9 in. stroke, are fixed diagonally on the frame with pistons working to the upright crank shaft. A small pinion at its lower end is geared to a wheel fixed to another upright shaft, the pinion and wheel being in the ratio of 1 to 4 in. diameter. At the lower end of this second shaft is the paw or chain wheel, which gives motion to the endless chain, and with the cutters fixed on it, performs the under-cutting. The chain is made from cast-steel and the cutters from tooth-steel. The jib is made so as to turn quite around underneath the frame. The machine feeds itself by means of a drum and chain passing round a pulley, which is fixed to a prop in advance. The machines are usually driven by compressed air, at a pressure of 35 to 40 lbs. per square inch, conveyed by cast-iron pipes from the top of the pit. The machine altogether, including the rails, stands from 20 to 24 inches in height, and is thus adapted for this reason alone for working very thin seams, through the small depth of the undercut ($2\frac{1}{2}$ in.) renders it peculiarly adaptable to thin seams. When in operation each machine is attended by two men and one boy, and the work is done at night time in a shift of from eight to ten hours. About twenty of these coal-cutters are in operation at the works of Messrs. Wm. Baird & Co., and twenty-five others in various parts of England and Scotland, some of these are of an old type, but the machine as now improved by the patentees after ten years of experimenting, has given surprising results in undercutting coal, from information which was laid before me by Mr. James Bronlie, 33 Bath street, Glasgow, from whom all details as to work performed and cost can be obtained. The work performed by one machine in a seam of coal 2 ft. 10 in. height is from 300 ft. to 350 ft., the coal being moderately hard, time 9 hours including stoppages. Allowing for waste in undercutting, in this case the production of coal in 320 ft. only would be 75 tons in a shift; but in working a seam of 5 ft. 4 in. thickness, the production of coal would be about double, or 150 tons in a shift; under these circumstances four of these machines would maintain an output for a colliery raising 600 tons daily. The coal usually falls down of itself after it is undercut, and the operation of breaking up and filling are performed by other workmen in day time.

I may state that Messrs. Baird & Co. are laying out one of their collieries at Bothwell Park on an entirely new principle. The colliery has been about 18 months in operation, and from 500 to 600 tons of coal is raised in a day from two pits 284 fms. in depth. The Gartsherrie coal-cutter undercuts the coal, four of them being in use, and the hauling underground is all effected by machines driven by compressed air. An air-compressor is placed at the top of each pit, the descending pipe in the up-cast pit being 9 in. in diameter; in this colliery the operations are performed entirely on new principles of mining, and there is no doubt the advantages I have before alluded to, will eventually be obtained by the proprietors. There is another use to which these cutters have been applied in Scotland—that is, in the oil shale works of Mr. Young. The under-cutting of the oil shale—a mineral much harder than coal—is effected by strong machines, on the same principle as the coal-cutters, but with cylinders of from 7 to 8 in. diameter, and of stronger parts; two such machines are, I understand, at work, and give some good results.—*Correspondence London Mining Journal.*

Allowing for Rail Expansion.—This is a point in practical railway building which, we see, was quite thoroughly discussed at the late meeting of the Master Mechanics' Association. In a paper by W. S. Huntington, the following table is introduced:

Length of rails, feet.	No. joints in a mile, one side of track.	Space for expansion, inch.	Fractions of an inch decimally expressed.			
15	352	.1026	1-64	.01562	1-2	.5000
16	330	.1090	1-32	.03125	9-16	.5625
18	293	.1228	1-16	.0625	5-8	.6250
20	264	.1863	1-8	.1250	11-16	.6875
21	251	.1434	3-16	.1875	3-4	.7500
28	188	.1914	1-4	.2500	13-16	.8125
30	176	.2044	5-16	.3125	7-8	.8750
36	146	.2465	3-8	.3750	15-16	.9375
40	132	.2725	7-16	.4375	1	1.0000

Among the reasons why it is best to be particular to have the rails the right distance apart at the joints are: If there is not room enough for expansion, the rails will bend to the form of a loop, causing death and destruction. And even if the compression is not sufficient to cause this, the effect on the traffic is destructive and causes breakages. If you are "out on the track" on a hot day, and the rails are "uncomfortably tight," and no trains in sight, you will be warned by the approach of one by the groaning and laboring of the track, as though it were a thing of life, and undergoing the most excruciating torture, or laboring like a ship in a storm at sea. The train may be two or three miles off, and out of sight, but you know it is coming by the cracking and snapping of the joints, as now and then a rail finds a little space and is thrust against its neighbor like a blow from a sledge. With this excessive compression on the rails and fish-bars, and the heavy rolling weight they are subjected to, the rails are strained and worked like a piece of tin bent back and forth between the thumb and fingers; and if there is a flaw or a weak spot it will soon amount to a crack and then break.—*Railway World*, iii, 1001.

MINING, METALLURGY AND MINERALOGY.

Ths Effects of Climate.—The case with which some ready writers can spin theories is curiously illustrated in a recent article in *Reform*, a journal published at Hamburg, in which the effect of climate on the people of the United States is discussed. The theory assumes that we are beginning in this country to resemble the North American Indians. The assumption is first made that our people are chiefly of English descent. Our skins have become dry. Our glandular system has shrunk to a minimum. Our necks are long; our heads small. Our cheek bones project. Our eye cavities are deep. Our under jaws are full. In all these particulars we are approximating the Indian. Furthermore, the Englishman is heavily bearded, the American lightly, the Indian not at all. Our hair is straightening. Our extremities are lengthening, so that American gloves have to be made with long, slender fingers. But this is not all. The change extends to our manners and customs; for instance, the Lynch law of the border and the polygamy of Utah show the proclivity toward the ways of the aborigines. Even the negroes here, we are told, are yielding to the climate, and are bleaching gradually. What a pity it is that the Indian chiefs failed to hear of all this, when they were recently at Washington. Instead of hoping to be civilized as white men are, they have only to wait and we shall become as they.—*N. Y. Tribune.*

MISCELLANEOUS.

Dessicating Eggs.—The egg traffic of this country has risen to an importance which few comprehend. The aggregate transactions in New York City alone must amount to fully $8,000,000 per annum, and in the United States to $18,000,000, the perishable nature of eggs has naturally detracted from their value as a standard article of diet. The peculiar excellence of eggs depends on their freshness. But lately the process of dessicating has been resorted to, and by this process the natural egg is converted into a vitreous substance of a delicate amber tint, in which form it is reduced seven-eighths in bulk compared with barreled eggs, and retains its properties for years unimpaired in any climate. In this form, eggs may be transported without injury, either to the Equator or to the Poles, and at any time can be restored to their original condition, by simply adding the water which has been artificially taken away. The chief egg dessicating companies are in St. Louis and New York. No salts or other extraneous matters are introduced in the process of dessicating, the product being simply a consolidated mixture of the yolk and albumen. Immense quantities of eggs are prepared in the spring of the year by liming. Thus treated, they are good for every purpose except boiling. It is a common fraud for some dealers to palm off eggs so treated as fresh, so that imposition is easily practised. In the dessicating process, however, the difference becomes apparent, as from four to five more limed eggs are required to make a pound of eggs dessicated than when fresh are used.—*Druggists' Circular*, ii, 196.

The Abuse of Saws.—Makers are annoyed by having saws returned to them for repair in such a condition that it is impossible they should go through the wood, from the miserable way in which they have been filed and set—some jammed all to pieces, some not half filed, some not filed true on the face or back, while others are all shapes but the right one in the throat, leaving no chamber room for dust and chips. Some saws have a bad pitch, some no pitch at all; some out of round; some with irregular or long and short teeth, one up and one down. In many cases they are returned broken. Why? Each tooth of a 24-inch circular saw goes through the wood 2000 times per minute, 120,000 per hour, 1,200,000 times per day, and if not sharp, the saw is strained at the root of the tooth. This frequently not only closes the set, but must eventually break the saw, for although steel is strong, continual straining will make it tender, and it must break. The tooth becomes dull on the side or under the point in proportion to the amount of feed; thus, if the tooth takes one-eighth of an inch hold at each revolution, it will become dull for one-eigth inch below the point, or more if feed be greater. A diamond will not cut if dull; why should a saw? A few minutes' filing two or three times a day will save tenfold the amount of time and labor expended in running an imperfect, dull saw, also making a saving in the amount of power consumed; and a heavy percentage in the amount and quality of lumber cut. It is a mistaken idea that there is a saving by not taking time to sharpen a saw.—*N. Western Lumberman.*

On the Physical Effects of Cocoa.—E. B. Shuttleworth publishes a paper on the above subject in the Canadian *Pharmaceutical Journal.* During a period extending over a year and a half, experiments were tried with the drug by administering it to the members of the Toronto Lacrosse Club At the commencement of every match each player was served with from a drachm to a drachm and a half. This was chewed in small portions during the game, the saliva being swallowed. As a summing up of the trial, a majority of the experimenters were quite enthusiastically in favor of the use of the drug, while the balance remained indifferent, having derived no direct or apparent advantage from its use. Mr. Shuttleworth, after ample opportunity for observation afforded by experiment, concludes that the drug may be classed in the same category with tea and coffee, but that its effects are much more strongly marked. This view has also been advanced by Dr. Pigeaux, of Paris; he, however, observes that he found it less exciting to the nerves than either tea or coffee, but its action over the heart is twice that of the latter, and four times that of the former. Mons. Colpaert says that the brain is also affected. He remarks that, persons using cocoa for a great length of time, and in excess, are ultimately reduced to a complete state of mental imbecility or idiocy.

The Sponge Fisheries.—Returns of the sponge fisheries belonging to Greece show that there are at present 150 boats engaged in this trade, 40 of which have English diving-bells. Twenty-four of these boats belong to the Island of Ægina, and the remainder to to the islands of Kalymnos and Simi. Each of the boats, which are supplied with diving-bells, has a crew from 11 to 150; the others are manned by only four sailors, so that the total number of men engaged in fisheries may be put at about 1,000. They took last year more than 240 tons of sponges of different qualities, the total value being $368,000. Sponges of the finest quality are sold upon the spot at from $3.12 to $3.48 a pound, and the second qualities for rather less than $1.40. The fishermen have to pay a tax of 10 per cent. on the gross value of their takes. The cost of a diving apparatus is $1,067, or $24,680 for the forty now in use, and each vessel makes four voyages a year, taking about a ton of fine sponges. The divers remain under the water about six hours a day when they are fishing, and it is said that many of them die of suffocation, and that a great many of them lose their hearing after a few years of this work. The island of Ægina, whose divers are very renowned, is building nine new boats, which will be launched very shortly, and it is stated that the annual profits of the sponge fisheries were nearly $145,500 for that island alone.—*N. Y. Grocer.*

A New Industry at Oakland, California, in which the entrails of sheep are used in the production of what is pronounced an exceedingly strong and durable article of belting, has been previously referred to in the *Review.* The process of manufacture is described as follows: The entrails, which will average about fifty-five feet in length, are first thoroughly cleaned and then placed in vats of brine, where they remain some days. When thus prepared they are not much thicker than a piece of common cotton twine, and will sustain a weight of about ten pounds. The next stage in process of manufacture is to wind the prepared material on bobbins, after which the process is the same as in making common rope. This method is used to produce a round belt, but where a wide, flat belt is to be made, a loom is employed, and the five strands are woven together, as in ribbon manufacture. The flat belts are made of any size, and the round of sizes varying from one-sixteenth of an inch up to one inch and a half in diameter. The round belts are made either in the form of a smooth cord, or as ropes with from three to five large strands. The three-quarter inch rope is said to stand a strain of seven tons, and is guaranteed to last ten years. Hemp rope will last on an average not over three years. Three-eighths round cord, containing 150 strands, will endure a strain of about four tons.—*Com. Bull.*

A Whale Abattoir in Norway.—On a small island opposite to the town of Wadso, in the extreme north of Norway, an establishment has been founded by a Norwegian, Mr. Foyn, for the regular capture and slaughtering of whales. Small steamers go out to the fishing grounds, which are within easy reach of the island, and the capture is effected by firing from a cannon an iron bolt armed with four harpoons, and provided with a shell which explodes as soon as the whale makes traction upon the line. The carcasses are towed into the harbor and worked in the usual manner.—*New Remedies*, vi, 290.

—It appears from an Austrian return that, in 1876, Austria exported 43,369 tons of rails, as compared with 10,774 tons in 1875. In 1876, Austria also exported 3,794 tons of steel in ingots, as compared with 4,223 tons in 1875.....The old iron of burned locomotives, cars, etc., destroyed during the July riots, is now being assorted in Altoona. The wrought iron will be kept there for use in the shops, and the cast will be sent back to Pittsburg, where it has been disposed of to a manufacturing firm.....Both the bar mills in Chattanooga are running full and generally double time. Chattanooga can now furnish a railroad with almost anything it needs—passenger and freight cars, wheels, axles, fish-plates, rails, bolts, boilers, bridge work of any kind, etc.....A contract has been let for 2,975 tons of iron railway sleepers in Belgium. The Providence company has undertaken to supply the sleepers, which are on the Hilf system, at $24.60 per ton. The same company required $29.40 per ton for iron sleepers when it tendered in October, 1876.....The construction of the great railway wharf at St. Johns, New Brunswick, the contract price for which is $174,000, is proceeding rapidly, and a large portion of the work will be finished before spring. The wharf will be 660 feet long and 70 feet wide, and an arm running northerly has been finished. A wharf to the east is now being built to give increased space for shipping.....Projectors of a tunnel under the Hudson river, between Jersey City and Hoboken, commenced work a year or more ago on land belonging to the Delaware, Lackawanna and Western Railway Company. A jury recently assessed damages for the land so taken at $7,000. The tunnel projectors profess to be satisfied with the award. A similar suit is pending between the tunnel company and the Jersey Shore Improvement Company. The tunnel company hope to settle that suit without a trial, and as soon as that shall have been done, propose to put men at work at once.....Sail and steam vessels are required to be provided with bells to give alarm in foggy weather.....Efforts are being made to establish a direct trade with Brazil and other South American States .....Arrangements have just been completed for a monthly line of steamers between Philadelphia and the Mediterranean ports.....The exports of petroleum from Philadelphia to foreign countries since Jan. 1, 1877, were 37,981,149 gallons.....Unwashed combing wool, to the extent of 100,000 pounds, was sold in one lot last week, in Philadelphia, to a city manufacturer..... The highest premium, a gold medal, was awarded at the Berlin Exhibition to an American firm for their collective exhibition of American boot and shoe machinery.....The Zoological Society has just received a magnificent specimen of the zebu or Indian bull, (*Bos Indicus*) which is found in a domestic state all through India and into Northern Africa.

MANUFACTURING AND INDUSTRIAL NOTES.

—The Nashua (N. H.) Iron and Steel Company is making about $75,000 worth of improvements on its steel works.

—Twelve thousand sewing machine needles are made daily at the Domestic Needle Works, Middleboro, Mass. Fifteen thousand per month are sent to Australia.

—The Fitchburg (Mass.) Machine Works are filling a large order for the Boston & Albany R. R., for shop tools; also a large order for the Scott Foundry, at Reading, Pa. Several car loads have been shipped and another is being finished for shipment.

—A Steel Pen Company in Essex, Mass., employs about 200 hands in its works, mostly girls. Each pen passes through twenty to twenty-five distinct operations, many of which require special machinery and skilled operatives. The company exports pens to Canada, South America, Mexico, Cuba, and even to England. The steel used comes from Sheffield, in sheets 60 by 18 inches, 1-16 inch thick.

—The Wallingford community (Conn.) has started in the iron and britannia spoon manufacture, and is crowded with work.

—The business outlook at Wareham, Mass., is encouraging for the coming season. The three nail factories, the East Wareham plate mill, and the Franconia Iron and Steel Company's Works are all in operation, and they are likely to run on pretty full time until next spring.

—The American Knife Company, of Thomaston, Conn., which was burned out last spring, has completed probably the finest building of its kind in the United States. It is three stories high, including the basement grinding room, and one hundred and three feet by twenty-six.

—The Boston *Commercial Bulletin* says: "S. S. Putnam & Co., Neponset, Mass., horse nail manufacturers, have been induced by large orders (beyond their capacity to fill) to form a stock company, thereby largely increasing their facilities, and at the same time giving their workmen a chance to invest their earnings in stock."

—The old boiler works at Chester, Pa., are being fitted up for the manufacture of small printing presses, and forty hands will be employed.

—The Crane Iron Company's No. 3 furnace, at Catasauqua, Pa., was lighted on the 9th inst. Nos. 3, 4 and 6 are now in blast.

—The application in the Circuit Court of New York by Fairbanks of St. Johnsbury, Vermont, for an injunction against the Jacobus and Nimick Manufacturing Company, to restrain the latter from the manufacture of platform scales with the name "Fairbanks" has been denied, and the temporary injunction set aside.

—Thos. Potter, Son & Co., and G. W. Blebon & Son, Philadelphia, have recently exported to England and Germany about $100,000 worth of fine oil cloths.

—The Directors of the McKeesport (Pa.) Car and Locomotive Works, destroyed by fire on the 28th uit., have decided to re-build.

—Mackintosh, Hemphill & Co., of Pittsburg, Pa., are building a 35-inch blooming mill, with hydraulic tables and feeding rollers, for the new Martin Steel Works of the Roane Iron Company, Chattanooga. This mill will require about 160 tons of iron, and it is stated will be the largest of its kind in the country.

—The Lucy Furnace Company are having the Chalmers-Spence patent "air space" non-conducting covering applied to the hot blast piping of their new furnace. This covering was thoroughly tested on the blast piping of their old furnace, where it has been exposed to intense heat, with the most satisfactory results. Captain J. B. Eads, the eminent engineer, has also the "air space" covering applied to the steam piping, &c., of the new dredge boat, "G. W. R. Bayley." The Chalmers-Spence Company has also recently received orders for covering the pipes, boilers, &c., of four large iron steamships built by Messrs. John Roach & Son, at Chester. This would indicate that the "air space" is recognized by practical and scientific men as the best non-conductor of heat.—*Am. Man'f'r.*

—The Lake Shore Railroad Company is erecting a $19,000 iron bridge in place of the structure which fell at Ashtabula last winter.

—Eight tons of steel horse-shoes are being turned out per day at the Cleveland Rolling Mills. The company is 300 kegs behind in their orders.

—The New Albany (Ind.) Rail Mill has shipped nine car loads—ninety tons—of new rails to the O. & M. Railroad Company. This concern ships on an average six or seven car-loads a day.

—Gutta Percha Paint, manufactured by the Gutta Percha Paint Company, 17 and 19 Champlain street, Cleveland, is composed of gutta percha, white lead, oxide of zinc and linseed oil.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

National Academy of Sciences.—Abstracts of Important Papers.—*The Comparison of Colors.*—Prof. O. N. Rood presented two essays on this subject. They were entitled, "A Construction for the Study of the Contrast of Colors," and "The Photometric Comparison of the Light of Different Colors." He stated that the theory of the effect of superposing or mixing colors is tolerably well understood. A few illustrations of this theory were given. But in each case a course of reasoning is required to determine in advance what will be the effect of a given mixture. Professor Rood proposes to effect this at once, by means of a pair of diagrams, one of which is movable. They are concentric. Each is a circle containing the whole chromatic scale, the colors being so arranged that those which contrast most are opposite each other; those which are most alike are nearest together. The spaces which are occupied by the different tints vary very much. This chromatic scale has been prepared after much investigation on the part of Professor Rood. The diagram cards are simply copies of this scale. To ascertain the result of mixing any colors, it is only necessary to slide one card around on its centre, over the other, till the point of mixture is reached; the result can then be read off, measured and estimated. The mixtures that have been thus tested are those which are well-known in the experience of practical art, and the agreement of the results by diagrams, with those of practice, is wholly conclusive as to the correctness of the method.

Nearly all attempts at comparing the relative brightness of colors have proved unsatisfactory. Professor Rood tried over again many of the experiments of other investigators. When these came to be tested by numerical results they varied so greatly from obvious facts that no dependence could be placed upon them. These various experiments were described in detail. Finally, Professor Rood adopted a method which gave much closer conclusions. A circular revolving card was used. A strip of the color to be examined was applied all over the surface of the card except a circle in the center. The inner circle was then painted black. On the inner circle a segment of white was affixed. The card was then revolved, and presented an outer ring of a given color, and an inner circle of gray. The intensity of the gray was determined by the size of the white segment. By increasing the size of the segment a point was reached where the intensity of the gray seemed to equal the intensity of the ring of outside color. Then an excess of white segment was used, and gradually diminished, until again the intensities of the inner circle and outer ring seemed to correspond. The mean point between these two determinations was assumed as that at which the intensities were actually equal. These results were highly satisfactory. Among other consequences, the proof was furnished for a proposition that has hitherto been only regarded as unproved but probable. It is known as Grassman's second proposition, and is thus phrased: "The total luminosity of the mixture of two colored lights is equal to the sum of the intensities of the two components." In response to Professor Hilgard's inquiry, Professor Rood said that in this translation of the rule from the German, he did not mean to make a distinction between the term "luminosity" and "intensity." Having fixed the luminosity of a series of disks of different colors, it becomes easy to compare that of any mixtures of colors.

The Inner Satellite of Mars.—Professor Alexander said that when the rapid motion of the inner satellite of Mars was announced, he had felt moved to inquire how it had obtained its great angular velocity. With this view, he investigated the orbits of several comets that had come near the orbit of Mars, to ascertain whether some portion of their materials might have formed the satellite, judging from their velocities. The mathematical process of comparison was shown on the blackboard, the formulæ not being very intricate. But after a careful comparison of several comets, he found none that answered the requirements of the problem. He then turned his attention to the asteroidal orbits. Taking some of these at their perihelion, he found it fully within possibility that an asteroid might pass so near the orbit of Mars as to be drawn to that planet and, becoming a satellite, have the great velocity that is assigned. This observation is true of the following asteroids: Polyhymnia, Felicitas, Eurydice, Eva, Flora, Ariadne, and others. Professor Alexander does not assert that such is the origin of the newly found satellite, but that the results afford a plausible ground for such a conjecture. Similar calculations will not explain the presence of the outer satellite of Mars, as that has too low a velocity.

EDITORIAL CORRESPONDENCE.

Causes of Heat in the Interior of the Globe.

Some scientists express the opinion that our globe will ultimately break up through shrinkage by cooling off from the outside more and more until reaching a point, when there is not enough stability to keep the world together without splitting up into fragments and dropping out of existence as a whole. I cannot see how this is possible, as to the cooling off, because it would at once upset a sound theory.

Suppose this globe had been built up of arches, solidly resting on each other, all around a common centre of the hardest known material, how large a diameter could have been reached, this centre being the centre of gravity, until beginning to crush the under layers to powder, and thereby creating heat sufficient to melt this powder, and by so doing making spaces filled with heated and burning gases. Suppose the limit of the solidity for the under part should be 20 miles, and this world being in diameter about 8,000 miles, then layer being put on layer, the crush and heat would certainly be increased to that amount, and would produce such excessive heat that there must be an immense mass of lava inside of an exterior crust of a certain thickness, which varies according to the splash and wash off from the interior side of the shell by this molten lava, produced by the rotation of the globe. Unevenness being produced inside by the crumbling earlier or later of parts of the crust, this very thing producing more and more inequality of shell, by taking off from one place and setting on to another, it goes on until it reaches its limit, that is to say, it breaks through by what is called a volcanic eruption. The rotation of the globe being uniform, there are also outside influences which cause the eruption sometimes to close up again and break out in another place.

Now, our earth not being built up as aforesaid, it is none the less subject to the same laws of gravity and attraction, which cause the same results. The very fact of both the poles being flattened off confirms this theory, because the axis of the earth-ball being through the poles, there is less centrifugal force evolved and this becomes greater as we approach the equatorial line, where it has its maximum, and I believe this to be the main reason why eruptions are mostly found near the line. The whole action being influenced more or less by cosmical attractions and repulsions, "it will last to eternity."

A. DE BEAUMONT.

BIBLIOGRAPHIAL NOTICES.

FRAZER'S TABLES FOR THE DETERMINATION OF MINERALS. (Revised Edition) Philadelphia. J. B. Lippincott & Co., 1878. (119 pp. 8 vo), $2.00.

The Tables of Weisbach, upon which the author has much improved and enlarged, afford the student and amateur mineralogist, by far the readiest guide for the determination of a doubtful mineral. Some of these hand books for the use of students, are based, like that of Blum for example, upon the crystallographic peculiarities of minerals; and their utility is therefore limited to the determination of such specimens, as are distinctly crystallized; but since comparatively few of the minerals that come to hand outside of the cabinet, are distinctly crystallized, the usefulness of such a classification for practical work is very limited. Works like that of Blum, therefore, while they serve the excellent purpose of exercising the student in crystallographic study, afford but little help to the student in mineralogy outside of the lecture room.

Others like v. Kobell, have taken the plan of depending entirely upon the chemical behavior of the minerals, and have given the student, with the help of an elaborate and refined system of division and subdivision, by the application of simple reagents, a method tolerably certain, in the hands of those who carefully study and use it, of reaching a correct result by a process of exclusion. This system, although decidedly more useful than the crystallographic one before spoken of, inasmuch as it takes in *all* the mineral species, is in our opinion defective in that, in taking no account of a host of distinguishing and often characteristic physical properties—color, lustre, streak, crystallization, cleavage, hardness, &c., &c., it does not promote that education of the eye, which constitutes most of the difference between the dabbler and the expert mineralogist.

A more rational system, obviously, would be one by which the differentiation of mineral species into subdivisions shall be carried to the furthest extreme, upon the basis of their physical properties; and where this process fails in identifying the mineral, the more troublesome chemical behavior shall be appealed to for the decision as a *dernier resort*. This plan has been followed in the work under consideration, which we find to be very complete and reliable—affording the student who will use it intelligently, the advantage of a very refined system of physical selection (if we may coin a phrase that will express our meaning), which will enable him in the majority of cases to determine his species, without resort to the objectionable *impedimenta* of the laboratory, Where the blowpipe and other chemical accessories are necessary, however, to be appealed to to decide a troublesome case, the student will find the required directions given for this purpose.

The Tables of Professor Frazer are based upon those of Weisbach, but the author has amplified and improved in several particulars, and we can recommend it with much satisfaction to all students of this interesting branch of science.

W.

PRACTICAL HINTS ON THE SELECTION AND USE OF THE MICROSCOPE. By John Phin, Ed. of *The American Journal of Microscopy*. 2d Ed. Fully illustrated, greatly enlarged. New York Industrial Publishing Co., 1877. (181 pp. 12 mo).

An admirable practical book of reference, in which the beginner and advanced student of microscopy will find a mine of useful information, concisely and lucidly expressed.

Prof. Phin's eminence as a microscopist is so well known to most of our readers, who will recall his clever expose of Prof. P. B. Wilson's misstatements in relation to the finding of diatoms in wheat-straw, that an endorsement of the reliability of his statements would be on our part a work of supererogation.

W.

SELECTED LIST OF U. S. PATENTS.

Patents issued Sept. 18, 1877, 234; Reissues 8; Designs, 8; Trade-Marks, 12; Labels, 6.

195,232. HORSE-SHOE MACHINE. Andrew J. Roberts, Boston, Mass.

A pawl-slide feeds the bar through a cut-off block across and above the plane of travel of the former. Two levers operated by a cam-groove in the rear end of the former, one of which is formed with a cutting edge while the other is forked, stride the forward end of the bar and force it down into the plane of the movement of the former at the same time the cut is being made. A pair of anti-friction rollers gives the initial bend to the blank as the former forces it between them, and the side dies press the partly bent blank to its ultimate shape and surround and sustain it while the nail-holes and creases are being punched. A projecting flange of the former is shaped on its under face to press and form the upper surface of the shoe. Channels for admission of water are formed between the die-head and die. A pin on the forked-lever knocks the completed shoe from the former.

195,234. APPARATUS FOR EXTINGUISHING FIRE IN CAR STOVES. Lawrence O. Root and L. I. Baker, East Minneapolis, Minn.

A water reservoir is adapted to be secured within a railroad car, and is provided with a tortuous passage connected with said reservoir, and adapted to communicate with the interior of the stove. The reservoir is provided with a spring-impelled piston, which is liberated by any unusually violent movement of the car. The spring causes the piston to force the water from the reservoir whenever liberated, and the fire within the stove is thereby extinguished.

195,235. REGULATORS FOR AUTOMATIC TELEGRAPHS. Wm. E. Sawyer, New York.

The transmitting movement automatically works a commutator, which changes the current from the transmitting and recording instruments to a single regulator which controls all the instruments in the line.

195,300. SMOKE EXCLUDING MASKS. George Nealley, New York.

A mask and cap of elastic material fits tightly to the head, the nose and mouth pieces being connected by one or more tubes with a series of filters suitably perforated and filled with damp sponge, which filters are again connected by one or more tubes with an elastic water-bag strapped around the neck or body, whereby the moisture of the sponges may be renewed at any moment. The wearer may pass through suffocating smoke with impunity.

195,303. PLOWS. Oscar F. Phillips, Lynchburg, Va.

The standard is constructed to fit upon the side of the beam opposite the mold-board. It gradually curves toward the mold-board side of the plow, and projects forward and rearward along the upper margin of the mold-board, from which edge it expands into a triangular plate which fits into a recess formed in the mold-board, and is secured there by bolts and nuts. The mold-board is thereby supported along its upper edge as well as along its front edge as heretofore. The upper end of the standard is armed with lateral flanges which embrace the plow-beam between them.

195,314. HYDRAULIC ENGINES. Wm. O. Wakefield. Boston, Mass.

The inlet valve is coupled to the piston rod so that the flow of water is gradually checked by the gradual closing of the valve, to permit the piston to be operated with a less head of water at the ends of the strokes.

195,381. PROCESS OF CHLORINATING ORES. J. Howell Mears, Philadelphia, Pa.

In treating ores, the process of chlorinating consists in mixing the ore with lime, and water in air-tight tanks, and introducing chlorine gas thereinto while in a state of agitation, then adding acid, and again agitating the mass whereby chlorine gas is evolved in the mass of ore under pressure.

195,416. CIRCULAR-SAW MILL. Frederick Strobel and Cicero M. Idleman, Marion, Ohio.

The head-setting mechanism is operated from the driving-shaft connected to the saw mandrel, and is thrown in and out of gear with such operating mechanism by means of eccentrics actuated by a lever connection and a long cogged roller mounted on a plate immediately over the eccentrics.

195,427. AUTOMATIC RECEIVING TABLES FOR PRINTING PRESSES. M. D. Wilkins, Bloomington, Ill.

The receiving table has slots through which guides reciprocate and act on the sides of the paper which is being delivered by the fly and push it against the adjustable stationary guide. The guides are operated either directly or by connection with the machine through the medium of cross-bars and connecting links on the underside of the table.

Patents issued Sept. 25, 1877, 267; Reissues, 5; Designs 5; Trade-Marks, 23; Labels, 4.

195,439. SEWING MACHINE TAKE-UP. A. Bocher, New York.

A rock-shaft projecting from the face-plate carries on its outer end the take-up arm, and on its inner portion an arm, which is thrown downward by a projection on the needle-bar, and upward by a spring. The extent and rapidity of both motions being controlled by the shape of the inner arm and its impelling projection.

195,443. MODE OF PRODUCING ELECTROTYPE MOLDS. William B. Closson, Boston, Mass.

This process consists in first covering the object with a thick coating of wax, next removing a section of the wax to a portion of the surface of the object, and coating such exposed surface with graphite or some proper substitute therefor, next in electro-plating such powdered surface, and then removing another section of the wax, and then powdering and electrotyping as before, and so on until the whole surface to be molded—each section of the mold thus made be formed or resting against one or more of the others.

195,457. STAMP MILL MORTARS. H. H. Scoville, Jr., Chicago, Ill.

A series of plates, amalgamated on both sides, are set in the side of the mortar in the line of the splash, whereby twice the usual amount of amalgamated surface is exposed in the same space, and there is a correspondingly increased saving of metal.

PATENT OFFICE MODELS.

(CORRECTION.) Of the two communications on this subject which appeared in our last issue, the first was originally published in the *National Republican*, at Washington.

The second was written for, but not published in the said paper. We inadvertently omitted to introduce the name of the author, (Mr. H. Howson), of the second communication.

EDITORS.

THE

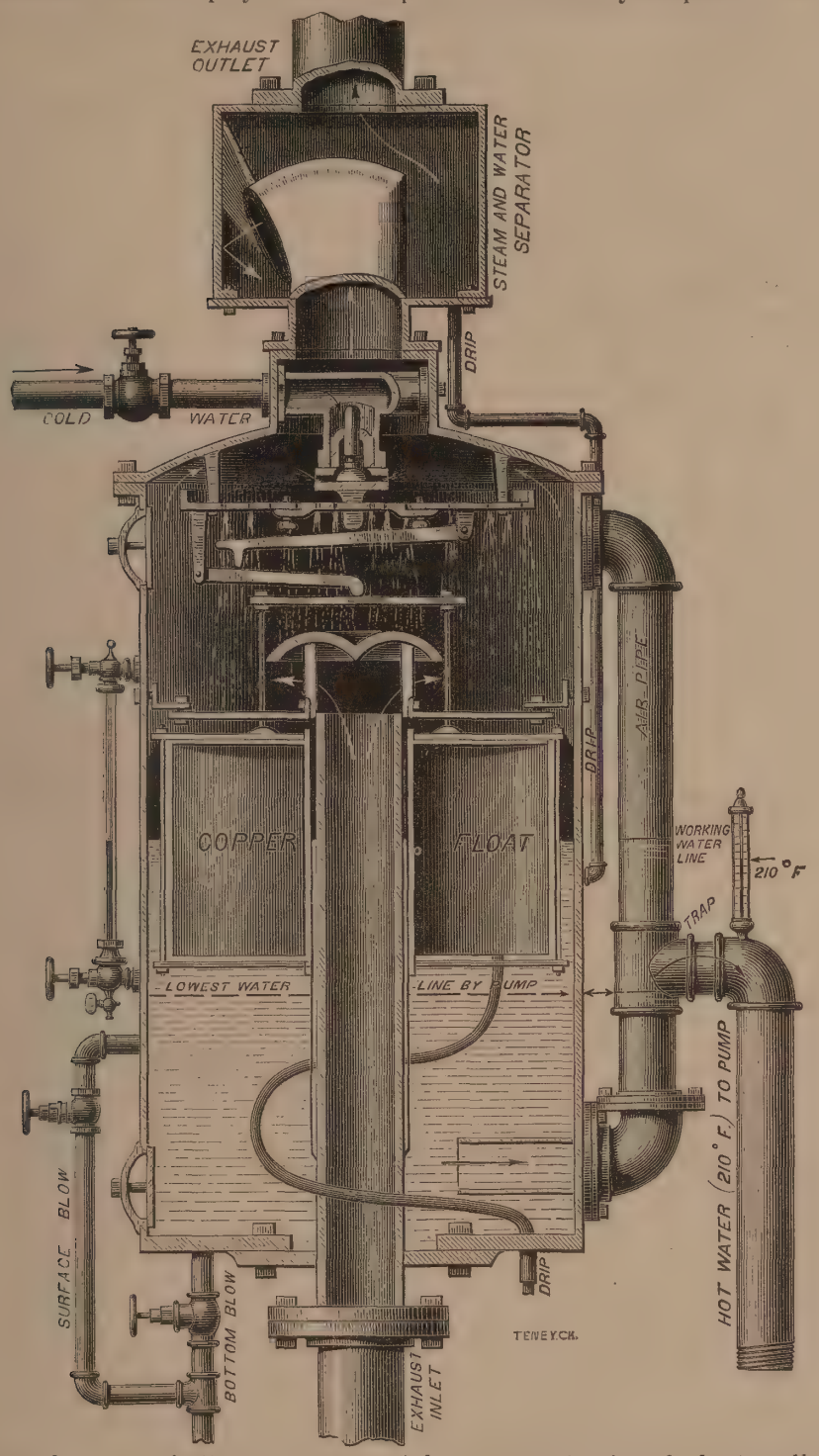
POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, NOVEMBER 10, 1877. No. 19.

THE "GREEN PATENT" FEED WATER HEATER.*

In this device, as described in the words of the manufacturer, "the cold water enters the heater by the pipe marked 'cold water,' passing through an open or poppet valve, as inside of the heater, is thrown upon a perforated plate, through which it passes, falling in the form of rain or spray. The float operates this valve by compound levers, and



so controls, automatically, any pressure of the water coming into the heater, allowing no more water to enter than is wanted by the pump for the boilers, or for other mechanical purposes. The exhaust steam enters at the bottom of heater through the large central pipe (which pipe corresponds in size with the exhaust pipe from engine), and striking against the disk seen at its top, is directed laterally against the falling spray of water, heating it instantly to its utmost capacity or boiling point. The surplus steam then passes around the perforated plate into the steam and water separating box, as seen at the top of heater. The hood or pipe inside of box deflects the steam against the sides and bottom, and by an expansion of the steam, drops to the bottom of box any water taken up from within the heater; the steam passing into the "*exhaust outlet*" perfectly dry, while the water dropped from the steam, passes by a "*drip pipe*" to the body of the heater below.

The water in the heater flows out to the feed pump through the large pipe on the right, to which is connected an "*air pipe*," in consequence of which it will be noticed that the body of water in heater cannot be pumped down lower than the line marked "*lowest water line by pump*," as when such level or line is reached the pump takes in air and steam. This lowest pumping line of water, holding upon its surface any dirt or grease is removed daily by the pipe and valve on the left marked "*surface blow*," while the collection of dirt at the bottom of heater is removed weekly by the pipe and valve marked "*bottom blow*."

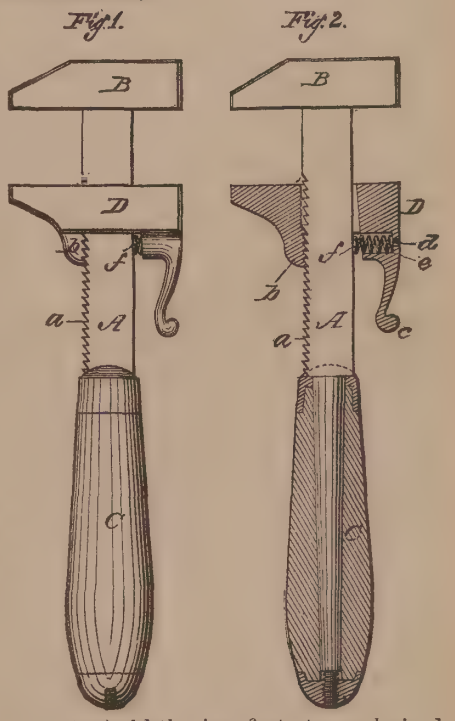
The float is constructed of copper on the outside, and is strengthened beyond the possibility of injury from either pressure or collapse, by a strong cedar barrel, well made and hooped, fitting the inside of float. The float thus constructed is perfectly reliable; but as an additional safe-guard, a spiral brass tube, (called in cut a "drip") is coupled to and enters the bottom of float, and passing down through the bottom of heater, acts as a drip in case of leakage, enabling the float to perform its duty until the leakage in float is greater than the capacity of drain by the drip. Furthermore, the atmosphere passing in and out of float by such brass tube, it becomes the means of safety against any tendency to collapse.

An iron plate or apron is shown in the cut just above the float, which protects the float from the pulsations of the steam, and so, not only aids the float in keeping the water quiet below, but the drops of water falling upon it from above rebound, giving the steam another chance of heating it before it passes off at the sides to the well below.

Two large hand holes are provided in the upper part of heater, by which the valve and upper working parts of heater are reached with great readiness and efficiency. There is also one large hand hole near the bottom by which the drip pipe attached to float, and any accumulation of dirt in the bottom of the heater can be readily handled."

*Made by the Green Feed Water Heater Co., 86 Liberty Street, New York City.

IMPROVEMENT IN WRENCHES.*



"The invention relates to that class of wrenches in which a sliding jaw is mounted on a rack-bar, and caused to lock fast thereon by means of a spring, and the object of the invention is to lessen the expense of making and applying the spring to protect it from injury, and to admit of its being readily replaced by a new one without removing the jaw from the wrench; to which end the invention consists in casting the jaw with a suitable socket and mounting a spiral spring therein in such manner as to bear directly on the bar and leave its inner end exposed so that it may be grasped and drawn out of the socket, and in forming a small opening in the back of the socket, through which a new spring may be inserted. *A* represents the body or bar of the wrench, provided on its face with transverse ratchet-teeth *a*, and on opposite ends with a fixed jaw *B*, and a handle *C*, which latter may be made of any suitable form and attached in any suitable manner, or omitted entirely. *D* represents the sliding jaw, mounted on the bar *A* and provided with a toothed arm, *b*, which may be caused to engage in the tooth of the bar, so as to hold the jaw fast at any desired point thereon. The opening through the sliding jaw to receive the bar *A* is widened or enlarged at the rear, as shown, in order to permit the jaw to rock or tilt sufficiently to engage and disengage the arm *b*. On the rear side of the sliding jaw there is formed a rigid arm or thumb-piece, *c*, extending toward the handle, as shown, so that the attendant, grasping the wrench in one hand, can, by placing his thumb on the piece *c*, unlock and move the jaw at will. On the inside of the back of the sliding jaw there is formed a round socket *e*, in which there is mounted a spiral spring *f*, bearing on the back of the bar *A*, and causing the sliding jaw to lock fast and remain locked whenever the operator removes his thumb from the arm *c*. In constructing the wrench the spring may be, and generally is, inserted through the interior of the jaw into the socket before the jaw is applied to the bar *A*. In order that a new spring way be introduced after the jaw is applied and the handle fastened on the bar, so as to prevent the removal of the jaw, a small hole, *d*, is made through the back of the jaw into the socket, as shown in figure 2. The old spring being first removed by taking hold of its inner end and drawing it forcibly out of the socket, one end of the new spring is inserted into the hole *d*, and the spring rotated and pressed forward until it is wormed or screwed wholly into the socket.

In making the wrench the movable jaw is cast complete, with the socket and the hole *d* therein, ready to receive the spring, without being finished or fitted in any respect. The spring, which may be formed from brass or steel wire at a trifling cost, requires none of the filing, drilling, or other fitting necessary to the customary flat steel springs, and, unlike them, is seated loosely in its place without requiring screws, pins, or other devices to retain it in place. By my method of constructing and arranging the parts the inventor claims to greatly reduce the usual cost of constructing this class of wrenches, while at the same time giving the spring a better protection than usual against dirt and rough usage, and also employing a spring, which is less liable to be set or broken than the flat steel springs hitherto employed."

*Patented May 19th, 1877, by Samuel C. England, of Moline, Illinois.

THE "WATER-GAS" CONTROVERSY.

We give below, for the attentive consideration of our readers, the official report of Profs. Rogers and Stevens, on the Lowe Gas process as operated at the Manayunk Station of the Philadelphia Gas Works, together with a criticism thereon by Mr. Geo. S. Dwight, which will be read with interest.

One of the many curious things in relation to this subject, is the wide diversity of opinion respecting the character and value of the Lowe process, as a practical substitute for gas made from coal in the ordinary way; and the fact that while the abandonment of the experimental works at Manayunk is (as we understand) now being seriously mooted by the authorities, the Lowe process is about going into operation on a scale far larger than any hitherto attempted, in Baltimore.

After a careful examination of the report of the learned experts of the Phila. Gas Trust, we see no reason for modifying the favorable opinion that we have long entertained of the capabilities of the Lowe process, as a practical method of producing a permanent lighting gas of any desired degree of illuminating power, more rapidly and cheaply than by any other known process, in which opinion we are sustained by the most eminent gas chemists of the country.

A comparison of the chemical composition of the Lowe gas, with that of the coal gas furnished to the City of Philadelphia, as given in the report, although showing for the Lowe gas a considerable variation in the relative percentages of hydrogen and Marsh gas, is very favorable for it, both in respect to the high percentage of illuminating constituents, and the notably small percentages of illuminating impurities (carbonic acid, ammonia, and sulphuretted-hydrogen). The only objection that the experts make against the Lowe gas as supplied at Manayunk, is on the score of its alleged illuminating power, an inference which, with all respect to the accuracy of the observations on which the experts' report is based, does not appear to us to be warranted, if the chemical analyses of the two kinds of gas, which are presented, are subjected to a rational interpretation. But, admitting the experts' objection to be warranted by the facts, they practically nullify it by the candid admission that the illuminating quality of the Lowe Gas, is a factor that can be controlled at pleasure by the manufacturers, by the employment of a larger or smaller quantity of oil.

A great deal has been written and said of the Lowe process that savors of a disposition to damn it on general principles, because, forsooth, it is an innovation upon established usage although we beg to state that nothing is further from our intentions than to intimate anything but perfect fairness, on the part of the eminent gentlemen who have made the report below given.

A report, however, like that upon "The Lowe Gas at Harrisburg," which appears in the last issue of the *American Gas Light Journal*, so far from contributing anything of value to the settlement of a problem that has occupied the earnest attention of gas chemists for the better part of the present century, will not strengthen the reputation of its author, but in its painfully apparent efforts to make out a case, it forfeits what consideration it might have been entitled to receive, as a fair presentation of one side of the subject; as it stands, however, as a very competent critic tersely expressed himself, it is neither *ex parte* nor expert(e). W.

REPORT OF PROFS. ROGERS AND STEVENS ON THE LOWE PROCESS AT MANAYUNK.

Gentlemen—In accordance with a request made by chief engineer, Mr. Thomas R. Brown, that we should examine the Lowe process for the manufacture of illuminating gas, as conducted in the works constructed by that company, on the premises of the Manayunk Gas Works; test its illuminating power, and determine its chemical composition and its quality to resist low degrees of temperature and report upon the same, and also upon any points of incidental importance that might present themselves during the investigation; with a view to the availability of said gas for city lighting purposes, either when used alone or when mixed with the ordinary city gas, as at present manufactured from coal, we beg to submit the following report. With a view to render intelligible any remarks that may be made in connection with chemical actions, supposed to take place in the operation, it is deemed by us proper to here append a wood cut and description of the arrangement and process as given by the inventor. (As this journal has heretefore published the description they are omitted.)

The investigation which was submitted to us, began December 27th, 1876, and in its several directions has been pursued with many interruptions, owing to engrossing professional engagements up to a recent date.

A great number of experiments have been made of a preliminary and comparative kind, having reference to methods of gas analysis, etc. It has been thought by us best to omit reference to such and to confine this communication for the most part to the facts bearing directly upon the question with the gas trust, as to the availability of the Lowe gas as a substitute in part or entirely for the ordinary illuminating gas from coal. The photometrical testing of the Lowe Gas, as manufactured in their works at Manayunk, was conducted under four different modes of collecting it.

In the first instance it was examined in the photometrical room of the works, being drawn directly from the large gas holder on the premises, and passed through the small meter to the standard burner.

In the second instance, owing to the large gas holder having been made the recipient of both the ordinary coal gas and the Lowe gas, and it not being the object to examine a mixture of such, it was collected in two large rubber bags, of five cubic feet each, from the outlet of the meter of the Lowe works and conveyed to the laboratory of Prof. Rogers, at the University of Pennsylvania, and from these bags transferred to a gasometer over water.

In the third instance it was collected in two rubber bags similar to those just mentioned, by tapping the pipe leading from the purifiers to the large meter. These were taken to the establishment of Mr. W. W. Goodwin, and there the gas was transferred to a gasometer and experimented on.

In the fourth instance a large tin gas holder of 20 cubic feet capacity was sent to the works at Manayunk, it was there filled with water and connected with the tube which was tapped into the pipe between the purifiers and meter of the works.

The water was then allowed to flow out and the gas to flow in. The opening of this holder was then soldered tight and the vessel conveyed to Mr. Goodwin's establishment. For experimenting on the gas, portions were successively transferred to a small gasometer.

The production of gas from each "charge" varies between 4000 and 6000 cubic feet and each operation "at running," during which the gas is made, lasts 30 minutes. Dividing off the 30 minutes into periods of five minutes each it is found that the quantity of gas produced is far greater during the earlier periods than the later ones, and that on the other hand the gas which comes over during the later intervals is much *richer* in illuminating materials than that which comes over during the earlier stages.

It was therefore a nice problem to so adjust the collection either in the bags or the larger vessel sent to the Manayunk works, as to secure a mixture that would represent accurately the average of its quality. However it is believed that with the precautions taken; no serious error has arisen from that source.

Yield of gas as observed by the meter for periods of five minutes each, up to the close of the run which in every case was of 30 minutes duration.

THE FIRST RUN.		SECOND RUN.	
1st. five minutes,	1,100 cubic feet.	1st. five minutes,	1,600 Cubic feet.
2d. " "	1,600 "	2d. " "	1,200 "
3d. " "	1,050 "	3d. " "	800 "
4th " "	750 "	4th " "	600 "
5th " "	650 "	5th " "	550 "
6th " "	450 "	6th " "	450 "
Total yield,	5,600	Total yield,	5,200

Consumption Anthracite coal 1st run, 248 lbs.
" Crude Petroleum, " " 16 galls.
" " " 2d " 17 "

The following are the results of photometric examination of the Lowe gas, as taken by the different modes, above alluded to.

Examination at Manayunk. Gas drawn directly from gas-holder, average of five one-minute observations, 12.51 candles.

To obtain 16 candle light it was necessary to burn 7½ cubic feet.

Examination at laboratory of Dr. R. E. Rogers', University of Pennsylvania, gas taken from Manayunk works, through large meter and transferred to small gasometer from bags, average of 10 one-minute observations, normal temperature, 13.95 candles. Average of five observations through coil, at temperature 0° 12.16 candles; pressure, .85 inches.

Examination at the establishment of W. W. Goodwin, Esq., Filbert above 10th street. Gas taken from pipe tapped between the purifiers and large meter and transferred to the small gasometer from bags at Mr. Goodwin's.

Average of ten one-minute observations, 14.45 candles; candle burning 120 grains; 15.hole argand burner, 7-inch chimney, pressure, .85.

Examination at the establishment of W. W. Goodwin, Esq., on the day after preceeding experiments. Gas of large vessel filled from pipe, tapped between purifier and large meter at Manayunk Lowe gas works, average of 21 one-minute observations; 15 candles. On freezing same at temperature 0° average of five one-minute observations, 10.30 candles. General average of all the observations, 13.48 candles.

With a view to test the effect of burning the Lowe gas with different burners, the following trials were made with the results appended. At the time of the experiment the city gas gave, with a 15-hole Sugg 16-candle burner, 17.75 candles. The Lowe gas gave with

a 16-candle,	15-hole	burner	average	12	candles.
a 16 "	24 "	"	"	12.5	"
a 14 "	21 "	"	"	10.5	"
a 19 "	27 "	"	"	9	"

Pressure at meter, .80 inch. A Sugg-bat's-wing, burning five cubic feet per hour and pressure one and one-half inches, 13.5 candles.

It thus would appear that for the Lowe gas the 16-candle burner is the best.

From the above results it would appear that the Lowe gas, manufactured at Manayunk and supplied to us in the manner described, is inferior in illuminating power to that of the city gas, as at present made from Bituminous coal. It should, however, be here stated that since the Lowe gas owes its illuminating value (all other things being equal), to the amount of hydrocarbons, it contains, derived from crude petroleum, it is in the power of the manufacturer to control within a wide range its quality, by the use of a larger or smaller quantity of the oil. The problem, therefore of the ability of the Lowe gas to compete with or replace the ordinary coal gas, resolves itself into the question, whether the cost of petroleum may be such as to admit of its being used in such large quantities as to produce a gas so highly charged with hydro-carbons, as to possess an illuminating power much beyond that found by us in the present instance.

Wishing to confine ourselves purely to the facts which have come within our observation, we will not undertake to say what may or may not be accomplished by any future experiments or improvements upon the present mode of manipulation or manufacture of the Lowe gas.

COMPOSITION OF THE LOWE GAS.

Without entering upon the question of whether this gas is of the variety known as "water gas," modified by a chemical reaction between such and the petroleum vapor, the settlement of which would require an investigation not within the scope of our instructions, we here append the average of several very carefully conducted analyses and a comparison of the same with the city gas made from coal. Analysis of Manayunk gas showing wide variations in composition.

Lowe gas brought from gas holder at Manayunk.		Lowe gas taken from pipe tapped between purifiers and large meter.		Analysis of city gas for comparison:	
Hydrogen	42.86.	Hydrogen	64.66	Hydrogen	47.72
Marsh gas	44.28.	Marsh gas	24.73	Marsh gas	38.53
Olefiant gas	5.18.	Olefiant gas	24.73	Olefiant gas	5.20
Carbonic oxide	3.43.	Carbonic oxide	2.72	Carbonic oxide	1.90
" acid	.69.	" acid	.19	" acid	.94
Sulphuretted hydrogen	.80.	Sulphuretted hydrogen	.80	Sulphuretted hydrogen	1.03
Oxygen	.14.	Oxygen	.41	Oxygen	.17
Nitrogen (estimated)	.56.	Nitrogen (estimated)	1.31	Nitrogen (estimated)	.85
Ammonia, &c	2.06.	Ammonia &c.(estimated)	.37	Ammonia,&c.(estimated)	3.06
	100.00		100.00		100.00

All of which is submitted. Very respectfully, your obedient servants,

(Signed) R. E. ROGERS,
(Signed) LEMUEL STEPHENS.

CRITICISM UPON THE REPORT OF PROFS. R. E. ROGERS AND LEMUEL STEVENS TO THE TRUSTEES OF THE PHILA. GAS WORKS UPON THE LOWE PROCESS AT MANAYUNK.

The investigation of new methods for the generation of illuminating gases, not only opens a wide and attractive field for the expert, full as it is of subtle questions in chemical analysis, but the subject is one of great popular interest. Our American communities have within the last few years reached the conviction that the cost of gas light is unreasonably high, and now occupy a position of antagonism toward the companies, such as led some time ago in England and Continental Europe, to stringent

Governmental interference between manufacturer and consumer. Hence the trial of the Lowe process upon an increased scale of practical operations, at Philada., was watched with much interest, because its uniform success on an ascending scale, at various other places had given promise of usefulness.

It was therefore with regret, not to say surprise, that after long delays it was rumored that the experts of the Gas Trust had reported adversely upon it. As a very spirited controversy is at present in progress in that city between the city council, the gas trustees and the press, as to the fairness of the trial accorded to the new system, a discussion to which many other communities are listening, a presentation of some facts connected with the examination by Drs. Rogers and Stevens, and an analysis of their report may be opportune.

It should be stated that the Works at Manayunk were erected without any cost to the Phila. Gas Co., by private parties, upon the folllwing terms:—

The contractor was to have control of the holder used for that district, and was privileged to make 200 M. cubic feet per day, at a specified price, provided so large a quantity was required for local distribution. On a fulfillment of the contract the cost of the Works was to be paid by the trust, which was thereafter to have license for use of the process on payment of a stipulated royalty. These facts are mentioned as interesting evidence that the onus of the trial lay on the contractor. It was provided that the gas delivered into holder should possess standard illuminating power, viz. sixteen candles, that it should not exceed .600 density, that its cost in holder should be within a prescribed price, and that it should be no more liable to condensation than coal gas.

These four points were left to the determination of Dr. R. E. Rogers, of Penna. University, and Prof. Lemuel Stevens, of Girard College, who upon the 11th of May last rendered this report. It is published in connection with this paper, and reference thereto is asked in the review which it is designed to make herein, of the circumstances attending the investigation and the methods employed.

First:—The circumstances at the time of the examination were peculiary unfavorable, and rendered it almost impossible to obtain accurate or trustworthy results.

The new method which up to this period had been making the entire supply for that District, was suddenly restricted to a small proportion, the remainder being derived from the coal-benches. The gas in holder was, in consequence, a mixed one which it was not desired to study, and the experts were therefore compelled to depend for their investigation upon samples, drawn back of the holder, at the meter inlet. This expedient is an exceedingly doubtful one,in any gas system,but is precarious in the extreme, in the Lowe process, which, in an increased degree, depends on the law of diffusion in holder for an equalization of the gases, which in their generation are inconstant, both in volume and quality. For this disadvantage the examiners were, of course, in no way responsible. They admit it embarrassed their labors, but they express the belief "that with the precautions taken, no serious error has arisen from that source." From this belief, however, the writer most respectfully but emphatically dissents, and not on theoretic grounds merely, but because the results and deductions of these gentlemen vary so widely from those reported by other experts, equally eminent, whose investigations at Manayunk, and elsewhere, were conducted under more favorable circumstances as to point to this fact as a source of error. If the Philadelphia trustees were sincerely desirous of settling strictly upon its merits, a question of great public importance, a period somewhat earlier or later might been selected for its determination, when the process was operating independently, and this grave disadvantage would thus have been avoided.

Second:—Another objection is raised against the treatment of the samples thus obtained; the taking of illuminating gas for test by water displacement and in rubber bags is not now practiced where accuracy is demanded, because of more or less action on the sensitive hydro-carbons, &c. Nor is the conveyance in midwinter over long distances, repeated transfers by means of water, and a suspension over the same for weeks, calculated to improve the luminosity of gas. Regarding the tests themselves as reported by Messrs. Rogers and Stevens, exception is taken to the manner in which they were many of them made, and especially to its form in which they are presented in the report, since by reason, principally, of the omission of data, it is not possible for their professional brethren to check their calculations and determine their correctness, hence the exact value of the examination is left undecided.

1st:—The question of condensibility, which is of great importance, since upon the permanency of a gas depends the ability of the manufacturer to give the distant consumer a satisfactory quality of light, beside saving the cost which loss in transit necessarily involves, is not commented upon. This is the stranger, since very interesting tests were made with remarkable results, as follows:—A coil of fifty feet of one-half inch lead pipe was packed in a cask of ice, snow and salt, until a temperature of zero was obtained, into which the Lowe gas was admitted and held for sixty minutes. Photometric observations before and after this test, showed a loss of illuminating value of less than one-half of one candle, and no deposit in the coil. For comparison, the city gas made from coal was similarly exposed, and ceased to burn in three minutes, leaving considerable residuum in the pipe.

2d:—The density of the gas is another matter not only of practical moment, but so indispensable in a determination of other questions under investigation, and for a verification of analysis, that the silence of the report on this point creates surprise.

3d:—The illuminating power of the Lowe gas seems to have been selected as the determining point of the whole investigation, and since its alleged insufficiency constitutes the sole and only objection raised against it by Messrs. Rogers & Stevens, and this is an objection never before raised, it will be pertinent to review with special care their treatment of this part of the examination. On the occasion of their first visit to Manayunk, it appears that the holder was in the control of the Lowe process, and a test is mentioned as having been made on the spot, which gave the value at 12.51 candles only. This is the only test free from the objections heretofore mentioned, but the report does not state in what kind of a burner the gas was used, and the entire experiment involved only five one-minute observations, so that its value is very questionable. It should here be remarked that as the principle of the determination of illuminating values is based upon the relative light given out by the consumption of 120 grains of spermaceti in comparison with 5 cubic feet of gas, during the same time, usually one hour, so it is extremely unsatisfactory to rely upon a few one-minute tests, because while the consumptiou of the gas is constant, that of the candle is variable, showing a difference, frequently, of several points in as many minutes. Moreover the density of a gas is in this connection entitled to consideration in the adaptation of the burner to its peculiarity in this respect. Certainly no just comparison lies between the illuminating power of the coal and Lowe gases, in the manner proposed by the experts of the Gas Trust. They assert that "at the time of the experiment the city gas gave with a 15-hole Sugg 16-candle burner, 17.75 candles." And then give the average aggregate result of 56 one-minute tests, variety of burner not stated, at 13.48 candles, and in this average is included ten observations at zero. In other words, these gentlemen would have one single test of Philadelphia gas, under the most favorable circumstances, decisive as against the average of a number of observations of the Lowe gas, many of which were made under peculiarly unfavorable conditions. It would have been an easy step to still further reduce the average value of the latter by introducing a test with the Bunsen burner. In enumerating trials of different burners, they report that a 19 candle 27 hole burner,gave only 9 candles, and yet this identical burner yields to other reputable experts at Manayunk, 19.81, and at Lancaster, 20.30 for the Lowe gas. Such glaring discrepancies as these, justify the inquiry whether in the investigation of Messrs. Rogers & Stevens any copper instruments or coils were used? The absorbing power of this metal on the luminous hydro-carbons is so well understood now, that it would not be employed when accurate determinations were desired.

On the basis of these observations, open as has been seen to very serious objections, the experts conclude "that the Lowe gas, manufactured at Manayunk and supplied to us *in the manner described* (the italics are used by the writer), is inferior in luminating power to that of the city gas as at present made from bituminous coal."

Then follows an acknowledgment which is a full concession of the whole matter, viz. "it should, however, be stated here that since the Lowe gas owes its illuminating value, all things being equal, to the amount of hydro-carbons it contains, derived from crude petroleum, *it is in the power of the manufacturer to control, within a wide range, its quality* by the use of a larger or smaller quantity of the oil." (Italics as before.) This admission virtually concedes the point at issue, the illuminating power having been the only ground of their objection to the system.

The question raised relative to the supply of petroleum, has been pretty well settled by events later than the report, but it may be interesting to state that coal-oil, which can be put into market at a competing price with petroleum, is at least equally desirable for enrichment, and presents a safe alternative to the manufacturer.

4th:—*Composition*—The analyses as the averages of repeated tests, are, if correct, very interesting and especially so as developing a feature entirely novel in the manufacture of gases into which water products enter. Reference is made to the unexpectedly small per centage of carbonic oxide, shown in the tables. So large a disappearance of oxygen is phenomenal and opens some exceedingly interesting chemical questions not pertinent here. It is to be regreted again that the density of the gas analyzed is not given, that the accuracy of the figures presented might be tested by computation. But for the purposes of this review the analyses are valuable to this extent, that they confirm the doubt already cast upon the photometrical observations. A comparison of the composition of the "Lowe gas taken from pipe tapped between purifiers and large meter," and which was the gas tested for candle power, with that of the city gas, leads to the conclusion that the former would burn with a higher illuminating value than the latter. Its percentage of olefiant gas is very nearly identical, with a strong probability of a larger proportion therein of acetylene, one of the most luminous hydro-carbons, while the marked increase of hydrogen in the Lowe gas should secure higher flame temperature, and a consequent increase of luminosity. In addition to this, the large decrease below the Philadelphia gas of those impurities which are known to reduce the candle-power of gases, is quite noticeable. The presence of the proportion of nitrogen and oxygen mentioned, it is believed might be charged to the entrance of atmospheric air into the sample, during the transfer.

Cost:—On this very practical point the experts express no opinion, but merely give, without comment, the quantities of coal and oil used, during the time of their investigation.

These, however, confirm the claim heretofore made, that 50 lbs. of anthracite and 3 gallons of crude petroleum are sufficient for the production of 1,000 cubic feet of illuminating gas, and strengthens the opinion that the Lowe process is capable, by its reduced cost of production, of competing with the manufacture of coal gas.

In conclusion, it is impossible to escape the conviction that for the purposes of determining so important a public matter as the possible supply of a good quality of illuminating gas,at a reduced price to the consumer,the report of Messrs. Rogers & Stevens is not competent, and this conclusion is reached solely by an analysis of the report itself, independent of examinations by other professional gentlemen, which may be presented hereafter.

GEO. S. DWIGHT.

THE MANUFACTURE OF WINDOW GLASS.

The manufacture of plate glass having been described in a recent issue of THE POLYTECHNIC REVIEW, we will devote our attention to the consideration of the processes involved in making "cylinder" or ordinary blown window-glass; the present article being based upon the workings of the Quinton Glass Works, near Salem, N. J.

The materials entering into the composition of the glass are clear sharp white sand (which is nearly pure silica), marble, lime and soda. It is designed to combine these, by the aid of heat so as to form a double silicate of soda and lime. As a matter of course, these ingredients should be so proportioned in mixture as to form a definite chemical compound. The sand comes from the neighborhood, the Quinton sand being white. The Quinton sand costs per ton of 2000 lbs., (damp) 60c. for digging and royalty, and 90c. for cartage 3½ miles; total $1.50 per ton. The sand is dried in a special house heated by a furnace having multitubular flues under the sand, and loses about 10 per cent. in drying; which may be put at about 100 lbs. of coal per ton of dry sand, or an expense of fuel for drying, of 25 cts. per ton of dry sand.

The soda comes from England and costs about $40 per ton, delivered at the works. The lime comes from Pennsylvania, and costs about $7.00 per ton, delivered. The proportions of ingredients are about as follows:

Soda,	30 lbs.
Lime,	28 lbs.
Quinton Sand,	100 lbs.
Total,	158 lbs.

The materials are well mixed together, by hoeing on a mixing floor, and are then ready for the melting.

The pots, which are about 32″ high, 36″ diameter, each holding 1000 lbs. of batch (sufficient to make 900 sq. feet of single thick glass,) are made of refractory clay, imported from near Bremen, in Germany. This clay comes in cubes about eight inches in each dimension and these are broken with a hammer to get out the nodules of iron ore which they contain, and which would ruin the pots. Some of the lumps are kiln-burned for 48 hours at a temperature of 1800°, and the burned lumps are broken up and crushed to the size of shot. Old pots broken up fine are used with the raw and burned clay in equal proportions of raw clay, burnt clay, and old pots. This batch is worked up with a very little water, and thoroughly kneaded by the feet in troughs holding about 4,000 lbs. This kneading and draining are continued for 25 days until the material is homogeneous, stiff, and thoroughly "tempered." The pots are made in sectional wooden tubs or moulds; they are about 2½″ thick and weigh about 400 lbs. each. After the mold is removed the pot stands about six months to season, and is then ready for the intense heat of the melting furnaces,(about 2000 degrees Fahrenheit.) A pot stands from 24 to 48 heats of 16 hours each; lasting from four to eight weeks.

The melting furnaces (there are two at the Quinton Works) each having eight pots, are built of stone made of clay, strongly clamped, and are fired with coal for the melting. To look at the flames and at the molten glass there is used a light wooden screen with blue glass eye holes, a projection in the shield enabling it to be held in front of the face by the teeth of the looker in, thus leaving both hands free. This blue glass causes the red or yellow hot flames and "metal" to appear brightly—even *icily*-white. On the molten "metal" in each pot floats a ring of crucible stuff, within which the impurities do not collect as they do outside.

After 16 hours melting, the fire is changed to wood, and the blowing begins. An iron tube with wooden encasing or handle, termed a *punta*, is thrust into the molten mass and gradually a ball of about 12 to 20 lbs. of glass is accumulated on the end. By blowing, twirling and swinging, attended with heating in one of the furnace mouths, this ball is blown into a pear-shape and then by blowing and swinging in a pit this takes the shape of a long cylinder. This is easily opened at the free end, and the whole is then laid on a wooden rack. A touch of a cold rod cracks off the neck; after cooled, tying a string of melted glass around the larger or outer end, cuts it off squarely and cleanly. The cylinder (or *roller* as it is termed) is then removed to the flattening house, first having been cracked lengthwise, parallel to the axis.

These rollers are about 50 inches long, 12 in diameter, and of the thickness of the window-glass desired. Each consequently has about 12 square feet of glass therein. The blowers, who mark their numbers upon each roll in chalk, are paid proportionally

to the net product; the flatteners and cutters are likewise interested in the quantity and quality of the product.

Fig. 1.

Fig. 2.

The Quinton works afford an admirable opportunity for contrasting the American and the Belgian flattening processes, since both systems are in operation. The American oven is circular, with a revolving table bearing seven flattening stones, made of pot composition, (each 40×66 inches, and five inches thick).

The flattening table revolves slowly, about once every ten minutes. The two fire holes are about 120 degrees apart; the fuel employed is coal; the hottest part of the oven is midway between the fire holes where the temperature is about 1400°. The roller being put in resting upon a stone, and with the longitudinal crack upward, the heat causes it to gradually unfold, so that at the hottest place it is unrolled flat. It is smoothed out with a gum-wood block kept wet, and by the time it has gone ⅔ round, it has partially cooled. It is then lifted off by a proper fork, and placed upon a rack car, upon a track in a long tangential passage-way at the side of the oven. By the time the sheets have emerged from this tunnel way they are quite hot, but stiff, and are then dusted off free from soot, and sent to the cutting room. The chalk mark of the blower, which was on the outer side of the roller, is upon the under side of the sheet, uneffaced.

The plan of the Belgian oven is entirely different, avoiding the fault of the American system, that if one sheet be slow in flattening, six others are not only delayed, but overheated and spoiled. The Belgian oven is slow but sure, and produces better

Fig. 3.

Fig. 4.

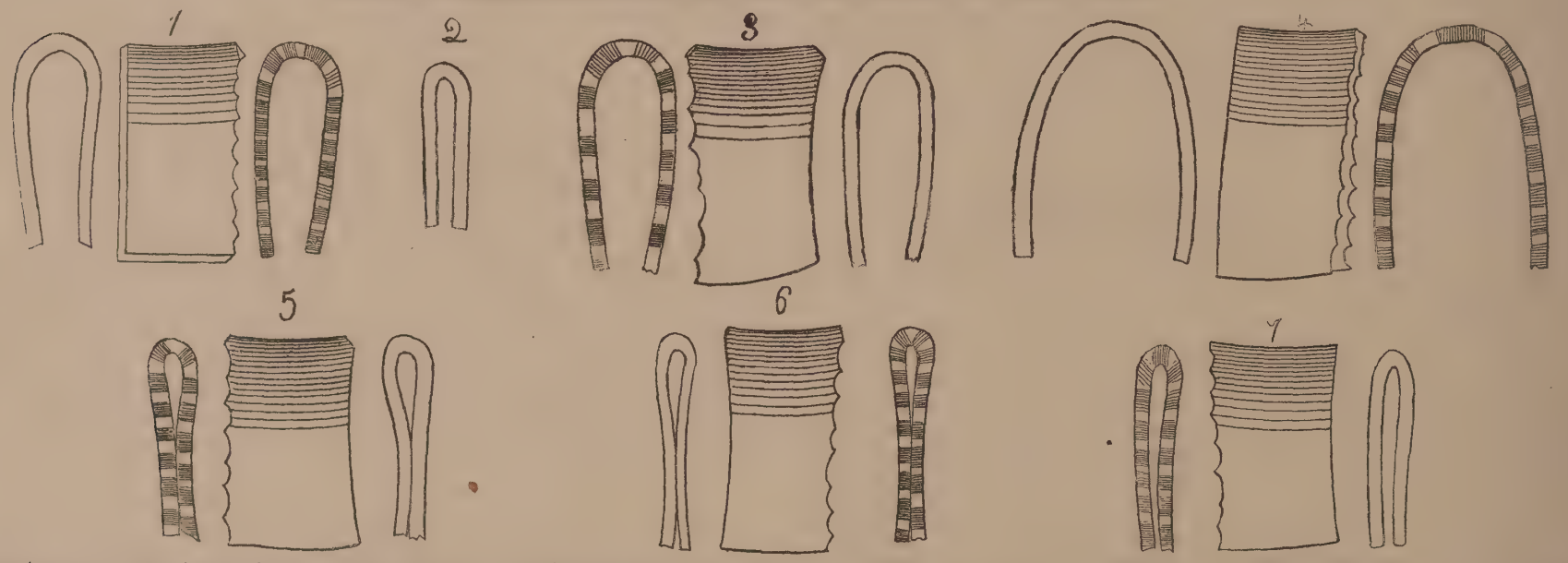
surfaced sheets. In are there is but two stones. Each is on a car; the roller is "unfolded" in one, and flattened and cooled in another; the roller being handed in by a crane with a suitable spoon-shaped arm. The car has no racks and the sheets are placed directly upon one another.

The "cutters" square the tops of each sheet, and cut it into such "size" as their judgment may dictate, being guided by the sizes and also by the condition of the surface, the various "sizes" being sorted into four grades. Each of these grades comes in single and double thickness as ordered and determined by the cutters. The sheets (which are all in regulation sizes) are packed in boxes each containing 50 square feet, of one size.

The waste in melting, handling and cutting is considerable, but the cuttings and the broken glass are re-melted, and hence the loss from this source is confined to the fuel and labor in re-handling.

A ton of batch produces about 1,600 lbs., or 1,600 square feet or single thick window-glass; the cost of production, divided, being about the following proportions. The works visited, cover about 15 acres including dwellings; having 34,000 sq. feet, under roof, for factory buildings. The ordinary working force is about as follows: Two master shearers, 16 under ditto, 18 blowers, 16 first helpers, 16 second ditto, 6 flatteners, 10 helpers about oven, 10 cutters and assorters, 2 packers, 5 pot makers and clay temperers, 4 box makers, 2 engineers, 2 blacksmiths, besides about 50 common laborers, wood sawyers, sand reachers, team drivers, &c. With this force there is turned out per week about 80,000 feet, the fuel needed being as follows: 100 tons of coal, 20 cords of wood, per week. G.

EFFECT OF PUNCHING AND DRILLING UPON THE TENACITY OF STEEL PLATES.*



Referring to our previous article† upon the effect of punching upon the tenacity and stretching of Bessemer plates, it was shown that alteration of elasticity in a ring around the punched holes was suspected. Experiments as to deformation by bending proved a decided alteration in elasticity in this region. "Natural" specimens sheared on one side and punched on the other, bent as shown in Fig. 1 before cracking; cracks showing themselves on the edges, (especially on the punched edges), and never in the middle. If we compare this with the results shown in Fig. 2, obtained with planed plates, we can see that both punching and shearing, especially punching, lessen the elasticity of the metal near where these operations take place. The experiments referred to in our last article would indicate that this altered region ought not to extend further than .58″ from the sheared or punched edges; and to test this, new specimens were punched with a .66″ cylindrical hole and .70″ die, and this hole reamed out with a drill so as to take away a ring of metal .039″, .078″ and .0117″ thick, thus giving holes .738″, .816″ and .894″ diameter. Breaking gave the following results:

Width of Specimen.	Final Diameters of Holes.	Resistance to rupture per square inch of original section.
Inches.	Inches.	Tons.
1. 95	.738″	32.23
1.95	.816	31.85
1.95	.894	32.30

This shows that while a specimen 1.95″ will, with a .66″ cylindrical punched hole, give a resistance of 25.88 tons (see table in last article), a similar strip with the same sized hole, enlarged by .078″ (giving .816″ hole), stood 32 tons. The reaming away the .039 ring evidently removed the space of weakening due to punching.

This experiment was repeated with a .31 inch plate. In the same plate were cut strips 2.34″ wide, with .70″ cylindrical holes (some bored, others punched .63″ and bored to .70″). In both cases the specimens were apparently identical; and the results were: drilled hole, 31.22 tons per square in.; punched and drilled hole, 32.20 tons per sq. in. Experiments from a thicker Bessemer plate (.46″) gave the following results:

	Width of Specimens.		Resistance to rupture per square inch of original section.
	Inches.	Inches.	Tons.
Drilled Holes,	.66	1.75	34.65
Punched Holes,	.66	1.75	27.78
" "	.58	1.75	34.02
Enlarged to	.66	1.75	
Punched,	.50	1.75	33.51
Enlarged to	.66	1.75	

This shows that plates from .27″ to .47″ thick have the injurious effect of the punch counteracted or removed by the removal of a ring .039 thick surrounding the holes.

In our next article we shall specially examine the region around these holes, with natural, tempered and annealed Bessemer and Martin steels. There remains for us in the present article but to consider the effect of punching upon Martin steel, and to consider if there be any other way of counteracting the injurious effects of the operation.

Natural Siemens-Martin plates, treated similarly to the Bessemer in Fig. 1, commenced to crack when reaching the form, shown in Fig. 3: the cracks appearing simultaneously on both edges. As the plates were .35″ thick, and the Bessemer only .31″, punching and shearing appear to act about the same on each kind of metal.

To note the effect of tempering upon punched steels, such strips as in Figs. 1 and 3 were heated cherry-red and tempered in cold water; and on bending, showed first cracks when as in Fig. 4 for Bessemer and 5 for Martin. With the tempered plates, the cracks showed as often in the centre as at the punched or the sheared edges; and if we compare them with the strips with planed edges (Fig. 2), but very slight differences can be seen.

Tempered and annealed strips (with punched and sheared edges as before) were brought to form Fig. 6 for Bessemer and Fig. 7 for Martin.

We thus may conclude: (1) that the effects of shearing and punching are local, extending less than .039″ from the sheared or punched edges. (2) That tempering destroys the evil effect of punching by bringing the metal to the normal state from which it had been disturbed.

In our next article we shall, among other things, also consider the effect of annealing both alone and after tempering. G.

*This article should have been printed before that on "Examination into the Condition of the Margins of Punched Holes in Steel Plates," on page 207 of our issue, bearing date Nov. 3. Notes in that article refer to *this* one; those in *this* article bear upon the second of the series, printed Oct. 27th. The mistake occurred in the absence of the writer.

†Page 199, No. 17, current volume, date of Oct. 27.

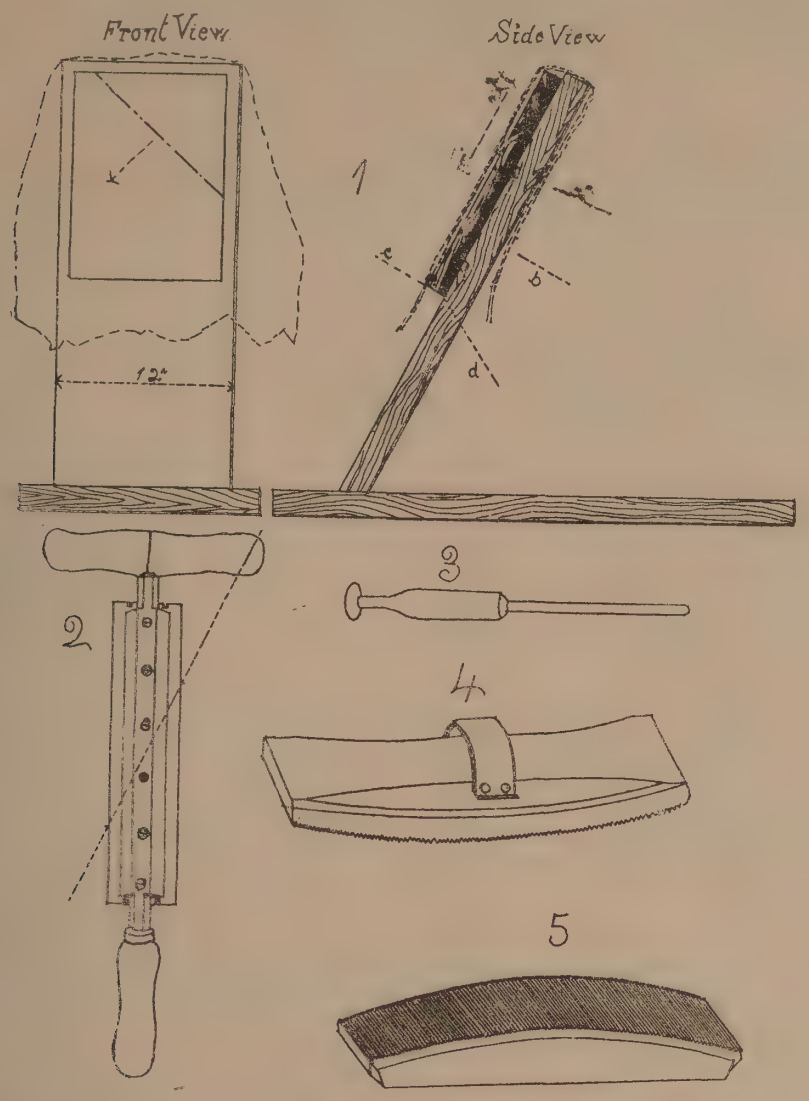
CURRYING OF LEATHER.

The term currying is derived from *coriarus*, man that works leather, called *corium* by the Latins.

After tanning, the leather is by no means finished, consequently not yet ready for sale, and is obliged to be put through several processes in order to obtain polish, color, &c.

There are many advantages derived from combining the tanning and currying establishments, the importance of which never seems to have been well understood in England, but in other countries this has frequently been done.

As before stated,* the great problem in tanning hides is to discover some method



by means of which the tannic acid can be made to penetrate the entire thickness of the skin in the shortest possible time. Greater the thickness, greater the difficulty to overcome. In the currier's hands this thickness is greatly reduced. Why not perform this operation partly before tanning is commenced?

Then, again, the skins, after having been tanned, are dried and then soaked in water, these operations causing loss of time, which would be to a certain extent avoided, when the above conditions are fulfilled.

My first idea was to give a general description of some of the most important curriers in this city in order that the reader might have some idea of how these operations are carried on; but found that the arrangement of the different rooms in which the currying was to take place, was more a question of circumstance than actual convenience.

A visit to the establishments of Messrs. J. Carrey, H. Colburn, Steinward, &c., on Dillwyn St., one can easily see that some operations that take place on the ground floor, in one case, are effected in the cellars in others, &c. Without doubt the soaking, in all cases, should take place where the water is most convenient, which generally is on the ground floor. In this room is a scouring stone, on which the leather is frequently scoured before and after soaking, (an operation that varies according to the currier), saturation should never take place, consequently the hides are not left too long in the water; frequently for that reason this operation is called *dipping*.

The currying of leather greatly varies according to the country, and the use it is intended for. For instance, in the manufacture of morocco, the currying in no way resembles the mechanical operations of hammering, by the means of which the material is rendered compact, when *sole leather* is the article desired.

The hammering is done by wooden or iron hammers, after having placed the hide on a polished slab; (various machines have frequently been patented, with the view of moving the hammers by different contrivances more or less complicated.)

I will not recommend one in particular, as the curriers each think their own the best, and for that reason it is impossible to ascertain the actual advantage of one over the other.

The principal operations of the curriers are the following:

1. *Soaking* or *dipping*.
2. *Treading* or *beating*.
3. Stretching.
4. Oiling.
5. Tallowing.
6. Dyeing.
7. Polishing.

The oiling and tallowing does not take place in sole leather manufacture, (as the purpose of these operations is to make the leather water-tight, &c. Hammering, as above described, answers the same purpose.)

*See REVIEW, Various Methods of Tanning.

In the following I will give the manufacture of *upper leather*, where a general application of the principles of currying will be observed: After the dipping is finished, the leather is frequently beaten with the foot, which renders, when necessary, the absorption of the oil or tallow greater. The leather is now placed on the *beam* (called *wooden leg* in England) or *horse*, which, in some cases, can be made to take any angle desired. The curriers in this city generally make use of a strong block of wood mortised at a given angle; the size of the beam varies according to the wishes of the workman, and, as a general rule, is made for his special use, (see Fig. 1). A piece of deal (*d*) is firmly screwed, on which is glued a plate of lignum (*c*.) The knees of the workman are placed at *b*. The arrow shows the direction of the knife. In France, their "*couteau a revers*" greatly resembles our sharp-edged cleaner; in both cases the handles are made in the same manner, one of which is perpendicular to the blade, and the other in the same plane (fig. 2), represents the knife used by the curriers in this city. All European curriers recommend the round knife for shaving and *paring* the skin upon the horse. (This knife is about 12 inches in diameter, with a hole about 4 or 5 inches in diameter in the center for introducing the hands. It is concave, and the form of a spherical cone; the concave part being that which is applied to the skin, and having an edge a little turned over on the side opposite to the skin, so as to prevent it from entering too far into the leather.

The shaving and paring operations consist in whitening the skins or cutting by the means of a knife first described.

The leather is placed on the beam and pressed by the workman's knees on one side, whilst the knife in a slanting position is made use of on the other. Great skill is required not to penetrate too far into the skin, but just sufficient to produce evenness. It is impossible to use the knife more than a few minutes without its losing its edge, which can be restored by the means of a small steel instrument resembling an awl. (See fig. 3.)

On account of the drying, the leather has lost the greater part of its grain, which must be restored, and consequently is submitted to the action of a *pommel*, (called crimping board), the size of which varies from 15 to 19 inches in length, and is made of hard wood, flat and smooth on the top, where a leather strap is placed, in which the workman puts his hand. The opposite side is convex; on its exterior surface are parallel notches forming grooves, the depth of which varies according to the size of the pommel. After continued use they wear, and are sharpened by the means of a file. (See pommel, figs. 4 and 5.)

The leather to be grained is placed and fastened on a dressing table, then rubbed strongly with the pommel. This mode of working renders the leather very flexible. Frequently leather requires no grain; in this case it is moistened and rubbed on both sides with pumice stone. In finer qualities of leather where great gloss is required the pommel is mostly of cork—when higher gloss still is wanted it is ironed and polished with stout pieces of glass, in the shape of a cylinder ten inches in length and three in diameter.

Stretching is an operation which is frequently found to render great qualities to leather. A stretching-iron is placed in a position perpendicular upon the leather—great uniformity of thickness is thus obtained—the leather is rendered smooth and compact. It would be well to submit all skins to this operation, for then no oil or tallow would be necessary. This leather is now placed in the drying-loft, where the dubbing operations take place, the wisdom of which is to prepare for the black color, which is frequently imparted in the case of sleeked leather, intended for harness work.

In this case two applications of black are generally necessary—often this is not sufficient, as spots remain where the red leather is still visible, then a third, and even fourth application, is found to render perfect uniformity of color. In this leather special care is taken to render it water-tight, as it is exposed to the variations of temperature. Consequently, tallowing is a very important operation. Before commencing, the flesh sides of the hide are drawn rapidly over a flame, produced by burning straw. The object of this operation is to render the absorption of the grease as great as possible. Mutton suet is the best, and renders the best results in the way of lustre, &c. It is heated and melted and spread upon the skin that is placed upon the table, the fleshy side receiving the grease, after which the substance is applied to the grain surface.

The leather, if too dry, should be moistened, in order that a certain humidity be obtained, which enables it to receive the above color.

Nearly every variety of shoe blacking contains a certain quantity of sulphuric acid, which, when frequently made use of, has a tendency to destroy the qualities of the leather to which it is applied.

The importance of imparting qualities that will partly diminish the action of the above can easily be understood. Rubbing the surface with a part compound of tallow, lamp black, yellow wax, soap and copperas, has the desired effect.

Various materials are made use of to give a lustre to the skins. Gum Arabic and sugar or molasses dissolved in beer and many other mixtures, have frequently been utilized with more or less success.

The great question in this manufacture (that can be solved by the chemist only) is to discover a black that will stand heat, cold, dampness, &c., and still retain its color.

Leathers made in China, Japan and other (so-called) uncivilized countries, were on exhibition at the Centennial. The black that was on their surface rendered our civilized product a darkish brown. Consequently, our men of science have not as yet solved a problem that gives no trouble to the yellow race, from whom we can learn much.

L. S. WARE, C. E.

ANOTHER FIVE DOLLAR IDEA.—STOKING.

Few stokers realize the waste of fuel consequent upon cold air holes through the fire, often occurring by carelessness.

With steam at 68 lbs., and temperature of water in boiler at 300° F., and with temperature of fire 1200° F., suppose $\frac{1}{20}$ of the grate to be bare, cold air rushing through with twenty times the freedom that it does through the fire, will dilute the products of combustion one-half, giving a resulting temperature equal the half sum of that of the air and fire flues, or say $\frac{60°+1200°}{2}=630°$

If the heating surfaces reduce the passing gases to 400°, one vol. will be reduced 1200°—400°=800°×1 vol., or with air hole 630°—400°=230°×2 vol.; or heat taken up will be as 800×1 to 230×2. or as 80 to 46 respectively, or a waste of nearly one-half. Keep the grate uniformly covered with fire. Yours truly,

S. W. ROBINSON.

THE EDUCATIONAL NEEDS OF AMERICA.

ABSTRACT OF AN ADDRESS DELIVERED AT THE OPENING OF THE WINTER COURSE OF LECTURES OF THE WAGNER FREE INSTITUTE OF SCIENCE, PHILA., MONDAY, OCTOBER 1, 1877.

BY WILLIAM H. WAHL.

We live in an age characterized, as compared with its predecessors, by the most extraordinary intellectual activity. On every side, investigators are prying into the mysterious twilight that separates the border land of human knowledge from the intellectual darkness that lies beyond. Fearless iconoclasts, heedless of the impotent vengeance of phantoms, which ignorance has clothed with the flesh and blood of reality, pitilessly tear away the mask that has, perhaps, for ages concealed from sight their deformities, and let in the light of truth to wither and destroy them; while, with more than the fabled power of the Titans of old, the mighty engines of civilization, argus-eyed, briarian-armed, million-tongued, with sinews of steel and nerves of lightning, ceaseless and tireless, serve at once to grace the triumph, to bear witness to the majesty, and to do the bidding of the intellect of man. With steam and the telegraph alone, science has revolutionized the world, created new industries, annihilated time and space, multiplied the productive capacity of the world a hundred thousand fold, taken into the cottage of the poor a thousand comforts, and has carried the torch of civilization and enlightenment to the remotest quarters of the earth.

And now to the application of these generalizations, for, like every story that is told, mine, I think, has also its moral, and it is this: The enormous progress and importance of the physical sciences, which we have in brief endeavored to portray, and the influence which they exert through the numberless channels by which such progression finds its application in the amelioration of the moral and physical condition of mankind, has made it long since obvious to thinking men that a knowledge of these things, so important in the affairs of the world beyond the school, should be taught there.

One of the happy results of this general recognition of the claims of science upon the educators of our youth, is to be found in the searching scrutiny and criticism to which the American college system has, of late years, been subjected, and the widespread reconstruction which is taking place to meet the requirements of the day.

The plan, so long followed in our colleges of high and low degree, of forcing all alike to take some one prescribed course of instruction, and to follow this inflexible curriculum, whether the studies therein included could be shown to be of future service or not, has happily, as one of the immediate results of this inquisition, been considerably modified, and in others entirely abandoned, to make way for the innovations imperative demanded by the practical needs of the day. The outgrowth of this sentiment has been eminently wholesome, although the changes in the system of instruction, which it has forced, are by no means so complete as the advocates of the "New Education" could desire. But the race of educators, who were taught to see in musty Latin and Greek histories and poems, peculiar virtues in the training of the mind, which do not exist in Shakespeare, Goethe or Schiller, and in the comprehension of vagaries of ancient philosophy, exercises in intellectual gymnastics vastly more improving than the comprehension of the laws of nature, under which they live and move and have their being, are slowly but surely following the incongruous Dodo, which unable to harmonize with its changed environment, gave up the contest with the inevitable, and became extinct. It is fortunate that this movement is still continuing, for in respect to the existence of a widespread scientific training and culture, the needs of America, in the proper development and utilization of her unparalleled wealth of natural resources, are larger, broader, and far more imperative, than those of other countries. We need, imperatively, the educated skill of scientific workmen in every department of technology, men who can rationally direct the tillage of our countless acres of productive soil, and the rational utilization and cultivation of our forests, that the ignorant impoverishment of the former, and the improvident and criminal destruction of the latter, may not, despite the exuberance of Nature's bounty to this, the richest of her continents, cover her face with the widespread desolation that has converted so many of the fairest garden spots of Asia and Europe into arid deserts; men who can direct us how to tap, with the magic wand of science, the rocky ribs of our hillsides and mountains, and force them to disgorge their hidden treasures; we need designers and constructors, who shall supply to skilled laborers, in other fields of industry, the tools, implements and machinery which will multiply their productive powers a hundred thousand fold, so that the products of multifarious industries shall be placed within the reach of the humblest and poorest of us. But above all, the preëminent merit of a widely disseminated scientific training will be to inspire men, who comprehend what science has done for civilization, through patient, faithful, unflagging and unselfish labor and study, with a genuine enthusiasm for the pursuit of truth for the truth's sake, with a keen conviction of the dignity of labor, with a thorough hatred of sham and pretense, and keen pleasure in the consciousness of work well done. With the wide extension of such a system of education as I have here pleaded for, will come the end of sham universities (save the mark!), that traffic in licenses to kill; of sham bridges and houses, that stand until their sham builders are paid for them; of sham public buildings, fire-proof in the specifications, and tinder-boxes within; of floating coffins, pretending to be iron ships, that break in half just when they should stay together, and there will be an end of the whole flourishing host of shammers, humbugs and charlatans that has invaded every trade and profession, to the detriment of honest worth and honest labor.

In agriculture, in architecture, in the several branches of engineering (mining, metallurgical, civil, mechanical and sanitary), and in the numberless fields of manufacturing industry, the demand for thoroughly skilled and educated men will become more and more urgent every year, and the best way to secure such men amongst us, is not to import them, or to send our young men abroad in seach of knowledge, but to *train them ourselves*. To do this, however, several things are necessary. We must be able to offer them the same inducements, the same opportunities, and the same educational liberties that can be obtained in the most favored schools of other countries. Hence, the establishment, in this country, of schools of applied science, where thorough technical training may be had, may be asserted to be an urgent duty which devolves upon those in whom the management and progress of our educational systems is vested—a duty upon the proper exercise of which the prosperity of the whole country is intimately involved.

As before remarked, the necessity of training men and women to become intelligent masters of the scientific principles underlying the practice of the useful arts, of teaching them the languages, the history—social, political and industrial—of the world that we live in, and the relations of the thousand and one things with which the real world, the world of living workers, in agriculture, trade, commerce and manufactures is interested—the necessity of doing this is reluctantly being admitted. It would be positively ludicrous, if it were not almost criminal, for our colleges to turn out, after four years of so-called training for life, a helpless creature whose stock in trade lies principally in his ability to scan you a Greek verse, or give you, on demand, a Latin quotation, to point a moral or adorn a tale; a walking encyclopedia of moods and tenses, and affixes and suffixes, who, when thrown upon his own resources, finds himself utterly helpless, and unprepared to take part in the real struggle for existence in that busy world of industry that knows nothing, and cares less to know, anything of dead languages and histories, that are about as useful to the men and women of to-day, as was the door-plate labelled *Thompson* with a P, which Mrs. Toodles has immortalized.

I have said that a change in the educational systems of the country was going on, in deference to the public demand for less Latin and Greek, and more learning of a useful kind. But the change is being made reluctantly and grudgingly by the friends of the old scholastic system, who are strongly intrenched in possession of the field, but that the innovation is making headway is manifested not only in the enlarged attention given in our colleges to scientific studies, and the general breaking down of the barriers which formerly hedged in the inflexible and traditional curriculum, and the planting, side by side with it, of the elective system; but likewise in the establishment of numerous specifically technological and industrial schools, having for their object the establishment of that close and rational relationship between the school and the practice beyond it, in the utter absence of which lies the failure of the old American College System. As may be expected, from the comparatively recent inauguration of such schools as these, their methods and interior organization are, as yet, comparatively imperfect, and their facilities limited. We should be thankful, however, for what little has been accomplished, and may, with confidence, anticipate that the movement in the direction of closing the breach between theory and practice will gather strength with every coming year.

An example of a technical school, as developed in the foremost European countries, will afford us a clearer conception of the imperfections of our own schools, by contrast, and on that account, the following outline of an average German polytechnicum is presented from a late report upon improved systems of technical instruction, made to the trustees of the Rensselaer Polytechnic Institute:

"In Germany, it may be well to state, the entire educational system, from its highest to its lowest departments, is under the direct supervision and maintenance of the Government. The question as to the propriety of a government undertaking the higher education of its citizens is not a matter of discussion—it is assumed as a duty and a privilege. The consequence may be seen in a thorough systematization and mutual independence of all the schools, from the highest to the lowest. Every school forms part of a great system, and sustains a rational relation to others, and the grading schools is made with a view that they shall present a gradually ascending plane, with no breaks in continuity. Each lower grade is preparatory to the grade above it, and the higher school begins where the next lower left off.

"Recognizing the necessity of supplying the wants of that great class of pupils who intend to devote their lives to technical pursuits, there is introduced at a certain grade a diverging point, from which the one branch leads to the university, which may, loosely speaking, represent the literary branch; the other culminates in the polytechnic school—the polytechnicum. Up to a certain point, it will be observed, the course of study for all pupils is uniform. Beyond it there is the gymnasium, a preparatory school for the university, and the real school, the preparatory school, for the polytechnicum. The student destined for the polytechnicum leaves the real school fully prepared by systematic training to commence at once the study of the higher and technical branches. The elements of general studies underlying the trade or profession which he intends to pursue have been thoroughly mastered, and it only remains for him to give his further attention to the special development of those branches closely related to his future pursuits. The higher school is not not hampered with the preparatory training of its pupils, but only with the strictly professional education of those thoroughly prepared to appreciate and comprehend.

"The following is a synopsis of the course of instruction pursued in the German polytechnic schools:

The school contains the following departments: I. The mathematical school, which is designed to comprise, in a separate course, nearly all the mathematical instruction which will be required, and thus leave the other and technical course free and unhampered. It is preparatory for three of the strictly technical courses, and the graduate in this department is still not entitled to a professional degree. The time of study in this department is two years. II. The school of civil engineering. In this the studies are almost purely technic and practical, with some branches of higher cultural studies. The candidate must be graduated at the mathematical school, or show that he possesses an equivalent amount of knowledge. The course in engineering proper is two and a half years. III. The school of architecture. The candidate must have graduated at the mathematical school, and his technical course lasts four years in addition. This is reckoned the most difficult and most learned of all the scientific professions, and perhaps a six years' course of preparatory study may in some degree account for the precision, economy and taste of the German architects. IV. Schools for foresters. The forests of Germany and France are under the protection of the government, and are cultivated scientifically, and in such a manner as to yield a constant and important revenue. The officers in charge of them are usually government officials, who are required to be men of education. Hence nearly every polytechnic school in those countries has its department of forestry, which is taught like any other useful art. The candidate enters the school from either the gymnasium or real school, and is not required to pass through the school of mathematics. The course is three years. V. This department conducts the education of certain classes of manufacturers, of chemists and druggists, and is besides, a preparatory course for mining and for metallurgy—branches which are

taught separately—in great establishments like the Freiberg school of mines and the Leoben metallurgical school. The preparation varies with the destination of the student, who must be at least 17 years of age. The time of study is also variable. VI. Mechanical engineering. The preparation must be in the mathematical school, and the technical course is two years. VII. Commercial school. The student enters from the Real school, and studies one year. VIII. School for the education of employès of the post-office. The student enters from the Real school, and studies two years. The course includes arithmetic, geography, political economy, popular jurisprudence, commercial law, the mechanics of transportation, modern history, French and German literature, and the English language. Thank God, there is one country in the world where civil employès of the government are required to know something. IX. Agricultural school. The student enters from the real school, and studies two and one-half years."

Upon this detailed synopsis the committee comment in the following terms: "Here there are nine departments, or, if you prefer, eight technical departments and one preparatory. Some polytechnic schools comprise more. But the branches of mining and metallurgy even then are taught in separate schools, located the one near the mines, the other near extensive furnace districts. All this may serve to convey some idea of the wonderful refinement of the science of education in Germany, and the exquisite adaptation of its means to ends."

But how painful and humilitating the contrast when we turn to our own country, where the field of the engineer or artisan is the widest, and where his education can be made to yield the largest results in economy of production and rapidity of development, and yet where the advantages of education are often doubted or even ignored.

"At the present time there are comparatively few schools in the United States which even resemble in their objects the polytechnic schools of Germany, and none which even approach them in the extent of ground they cover now in the thoroughness of their means and methods of instruction.

Some of our technical schools are doing most excellent work in the direction of enlarging their scope of usefulness, and the impression they are making upon the educational system of the country is manifesting itself more and more, but withal we are, despite our imperative needs, without a rational system of technical education."

One of America's most accomplished mechanical engineers lately expressed himself in the following terms:

"We need educated mechanics more than skilled workmen, for from the talents of the former class spring the improvements in processes and the machines which enable unskilled workmen not only to compete successfully with the skilled, but to number their trades with the lost arts. It is from the class of educated engineers and mechanics that all industrial progress must be expected. Intelligent labor is supplanting, and must everywhere continue to supplant, that which is ignorant and unreflecting; and that nation will be the most prosperous and powerful which strives most urgently to cultivate the intellect of its workers."

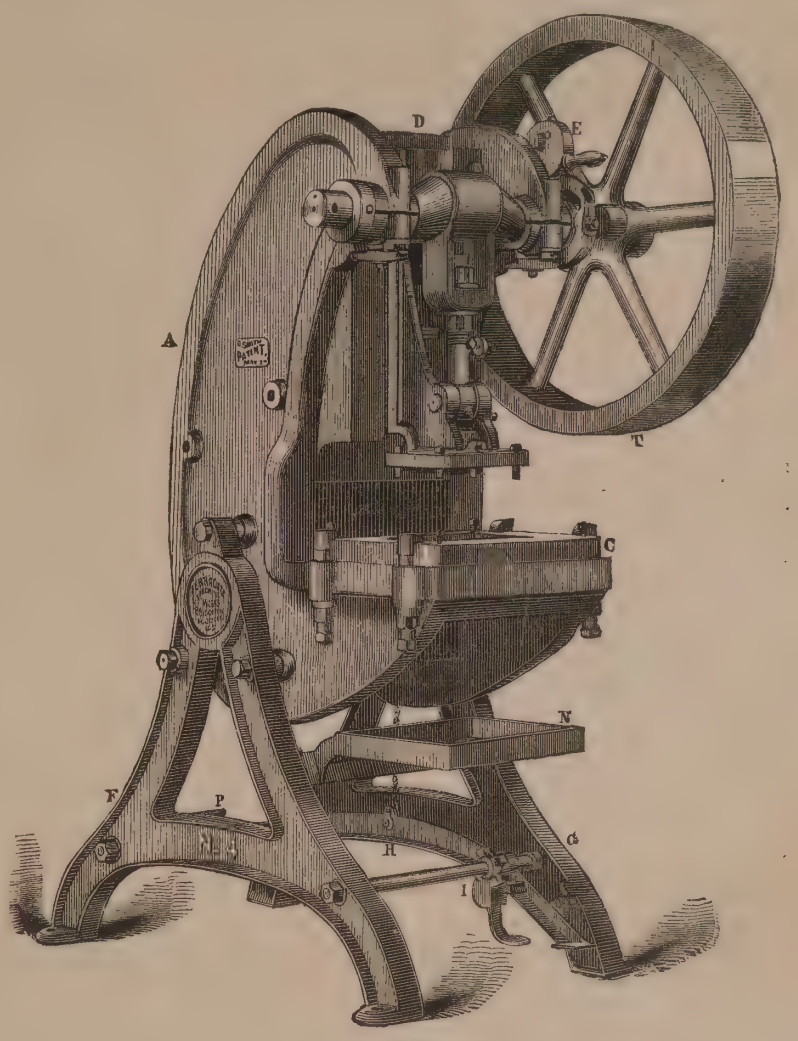
IMPROVED MACHINERY FOR WORKING SHEET METALS.

Machines, for whatever purpose they have been designed, in their primitive forms are bulky and unwieldy, capable perhaps of doing good work, (or what is considered such at the time,) but are generally characterized by their slow action, few conveniences, and doing in part what subsequent inventions will do in the whole. One would not suppose that the Evolution Theory could be applied to mechanical constructions, and yet the doctrine of the "survival of the fittest" is well illustrated in most of our factories where the lumber-rooms are stocked with old machines doomed to oblivion, their *principles* being incorporated in graceful and powerful machines which have taken their places in the work-shop, and are doing the work assigned them much more efficiently than their predecessors. And these in turn are improved, their several parts becoming more simple and their work more complex; manual labor is gradually dispensed with; the product of the machine is cheapened and consequently the use of the product becomes universal. Truly it is a progressive age when great inventions are born to an eventful life of a few years, being soon put to death by their own more vigorous offspring.

Machines for cutting and stamping tinware, in the early stages of the art, were supposed to require a large amount of power, and consequently the first contrivances were disproportionately heavy and unwieldy, possessed no conveniences, and had little or no adjustment. Later inventors naturally corrected the more glaring errors in construction, and this class of machinery has been improved until it has finally reached a high standard of excellence, both in construction and in quality of the product. The latest inventions of this line were on exhibition in several departments of the Centennial Exposition, the press we illustrate being exhibited by the Ferracute Machine Company, of Bridgeton, New Jersey.

This press is built of uniform design with a series of regular sizes known as Nos. 1, 2, 3, 4, 5, &c., its own number being 4. Suitable work for Nos. 3, 4 and 5 presses is sections of powder-kegs, fire-shovels, coal-hods, large varnish, paint, and petroleum cans, &c., &c. It is changeable, without extra cost, from "upright" to "inclined," simply by screwing on its legs in a different position. The frame is open-backed to a width greater than the hole through the bed, thus enabling work to pass back or sidewise. Among the improvements peculiar to it are: a main frame (*A*) very wide and deep, of a section giving a uniform strength throughout, the widths from all points counting from the front of the bed-back and up to the shaft journals, being derived from a parabola of the requisite form, and giving good scientific proportions; changeable legs which give a combined upright and inclined press for the cost of either separate; a very wide slide-bar (*D*) of dove-tail section, set back of and extending above the shaft, thus giving extraordinary length of bearing and consequent firmness and accuracy in the working of the dies; an automatic clutch attached to both treadle and hand lever (*E*) and provided with a positive stop so that it is impossible for the shaft to make more than one revolution by one action of the levers, also with an adjustable jaw for different speeds, and a safety-pin by which the shaft can be revolved to any position and the dies adjusted while the fly-wheel is in motion, thus dispensing with the need of a countershaft. This pin consists of a small light bolt with milled head, which may be screwed into a hole beside the clutch, and when placed in this position it effectually locks the clutch, preventing a stroke of the press if by accident the treadle should be touched. When not in use it is screwed into the end of the handle *E*.

The dies are secured in place by means of die clamps, consisting of hook headed steel bolts, sliding in long true holes, which descend upon and firmly hold the dies without the need of removing nuts, &c. This is an improvement on the old method of holding dies by bolts. A reversible treadle lock is shown at *I*, operated by the foot, and by which the treadle can be fastened *down* for continuous running or *up* for safety when the press is temporarily stopped. A treadle-bumper and stop of India rubber, which secures a noiseless and limited motion, journal clamps for accurately and firmly



setting the journal-caps without the use of lock-nuts, and a reversible catch-pin and shute (*N*) for catching or sliding off the work, are important improvements.

By the system of sectional patterns from which these machines are built, various modifications can be cheaply made, *e. g.*, with "open front" bed; with "horn" bed; with bed adjustable up and down and entirely removeable, &c. Another change of patterns consists in making the bed a size larger than the rest of the press, thus getting a larger opening for the work to drop through.

Strength and solidity are aimed at in these presses by putting the metal where it belongs. This secures a beauty of form which is enhanced by neatly rounded corners and a uniform style of painting, rather than by "rainbow work" and uselessly polished surfaces. The proportion of cost thus saved is well invested in extra conveniences and durability of construction. The latter quality is secured by careful workmanship, scraped surfaces, standard reamed holes, case-hardened bolts and nuts, steel shafts, clutches, pitmans, pitman nuts, die clamps, wrenches, &c. The pitman nuts have broad flanges bearing near the outer edge only, to prevent jarring loose. The press is provided with bolster plates, die-bolts, floor-bolts, steel wrenches, shaft-lever, &c.

The dimensions of the No. 4 Power Press which is illustrated above are as follows Weight, about 2,600 lbs.; height, from floor to top of fly-wheel, 82 inches; hole through bed-plate 10x14 inches, with a 12 inch circle in the centre; the width of the hole through the back, 15½ inches; the distance back from the centre of the slide-bar, 9 inches; height to slide-bar when up, 8½ inches; the stroke of slide-bar, 1¾ inches and its adjustment is the same. The diameter of the fly-wheel is 36 inches, and its speed per minute, 90 revolutions. P. K. R.

THE STEAM JET FOR BLOWING CUPOLAS.

M. Louis Pelatan describes a cupola at Norton, in the Cleveland district, furnished with air by means of a jet of steam. It is cylindrical, 4 feet 3 inches in diameter and 30 feet high, built of refractory brick with a sheet-iron casting. The upper part, by means of a horizontal flue, communicates with a sheet-iron column decending vertically into the ground, where it joins an underground flue leading to a chimney. A steam pipe of small diameter enters the sheet iron column, the jet of steam causing a current of the air in the cupola, which is furnished with 8 tuyeres 2 feet above the bottom. These tuyeres or openings may be closed at will. The result obtained were satisfactory, 5 tons of foundry iron being melted in an hour with, it is claimed, a saving of 5 per cent. of coke. There are four of these cupolas at Norton which four small boilers are found sufficient to supply with steam.—*Annales des Mines.*

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SLIDE VALVE GEARS.

By Hugo Bilgram, M. E.

Part III.

The Link Expansion Gear.

A change of the "lap" of the cut-off valve is not the only means for varying the expansion, the present valve-gear accomplishing the object by a variation of both the travel and the angular advance.

The main eccentric I (Fig. 71) is connected with the main-valve in the usual way. The cut-off eccentric imparts to the link $F°F$ a rocking motion on its fulcrum F. The link block B is directly attached to the stem of the cut-off valve, the latter being as shown in Fig. 58. A change of the cut-off is effected by a raising or lowering of the fulcrum F, by means of a screw or any other suitable mechanism.

When the link is raised so much that the pin $F°$ is in line with the valve-stem, the cut-off valve will be moved directly by the eccentric $I°$ (see Fig. 72). A lowering of the link implies a double change; first: the angular advance is varied by reason of the angular change of the eccentric rod $I°F°$ (Fig. 71.) and second: the travel is altered, the link-block

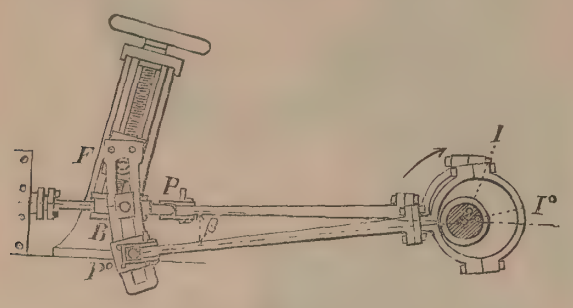

Fig. 71.

being nearer to the fulcrum of the link. The angular advance is increased by the angle $BOF° = \beta'$, and the travel is reduced in the ratio of BF to $F°F$. We can accordingly find the ideal eccentric i' (Fig. 72) of the corresponding movement of the

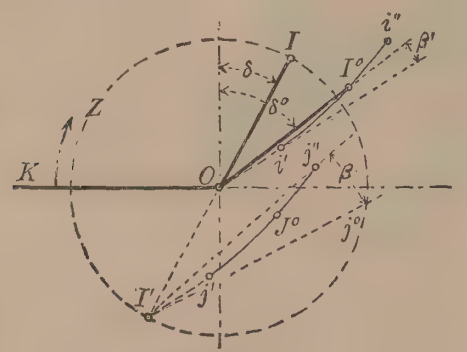

Fig. 72.

valve. A raising of the link will bring the ideal eccentric to i''.

For different elevations of the link the ideal eccentrics will again form a curve resembling the one found for the shifting-link, and by starting with similar assumptions this curve will again be a circular arc. In one point, however, there exists a marked difference. The curve of Fig. 72, if extended, passes through the centre O; for if the fulcrum F of the link (Fig. 71) could be lowered to be in line with the valve-stem, the movement of the valve would be zero.

This curve now relates to the *absolute* movement of the cut-off valve. To obtain the ideal eccentrics of the *relative* movement of the same we have to shift this curve in the direction of and through a distance equal to the line IO, when we obtain the arc $j'J°j''$, the extension of which passes through the point I' diametrically opposite the eccentric I.

The greatest absolute travel of the cut-off valve is equal to twice the length of the chord $I'j'' = Oi''$ of the *locus*, and if we draw the line $I'j°$ tangential, in I', to the *locus*, this line will form, with the chord $I'j''$, an angle, β, that is equal to the total angular change of the cut-off eccentric rod, supposing that the slot of the link was extended so far that the fulcrum of the link can be lowered to be in line with the valve-stem. This will be clear when we consider that the vertical inclination of the line $I'j°$ represents the angular advance as the link is lowered, while $I'j''$ represents the same as the link is raised all the way.

The valve diagram can now be obtained in the usual manner, and, assuming a negative lap, as shown in Fig. 58, the lap-circles can be drawn, when the diagram, Fig. 73, will give us all the information required. We see that the range of variation extends from OA to OE, but we also see that the rapidity of the cutting off is at the lowest figure at the middle grades that are likely to be used the most. It is true, the rapidity of the cutting off for those grades can be somewhat augmented, by an increase of the angle $\delta°$ (compare with Fig. 72), whereby the locus will be changed to a position indicated by a dotted arc, but this change is attended by a reduction of the range of the cut-off, this measure materially affecting the limit of the latest cut-off.

A greater curvature of the locus, attainable by lengthening

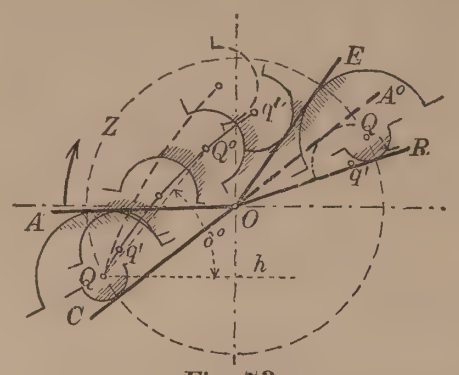

Fig. 73.

the link, or shortening the cut-off eccentric rod $I°F°$, Fig. 70, or both, will favor the sharpness of the cutting off at the middle grades.

In the case of the fulcrum F (Fig. 71) being on the lower end of the link (the engine running over) the curvature of the locus will be the reverse, and the valve-gear would give poor satisfaction, owing to the reduced travel of the middle grades. For this reason the fulcrum should be on that end of the link *towards* which the crank is rotating, in order to effect an *increase* of the angular advance of the cut-off eccentric simultaneously with a *reduction* of the travel of the valve, and *vice versa*.

The proper curvature of the link may be found by setting both the eccentric rod $I°P°$ (Fig. 71) and the link-block in their neutral positions, when a raising and lowering of the link should not produce any movement of the valve. One glance will show that the curve of the link should then be an arc from the centre O, provided the fulcrum F be moved in the same arc. It is, however, more convenient to guide the fulcrum in a straight line, and in this case the curve may be determined by means of a full sized model; (made of stiff paper or any other suitable material) consisting of the eccentric rod and the link. One end of the eccentric rod is pinned to the centre O of the crank-shaft (on the drawing sheet) and the other end is attached to the link. A pencil point is held directly over the neutral position of the link-block, and the link is then drawn through under it, by moving the fulcrum of the link in the line representing the contemplated guide. The pencil will thus delineate the required curve, which, though, will be found not to be a circular arc, and it can only be approximated in the practical execution. This curve will be more nearly circular if the fulcrum F is guided in an inclined line, conforming as near as possible to an arc, drawn from the centre O of the crank-shaft.

The lap of the cut-off valve is a factor, which, if not properly determined, may have a prejudicial influence upon the rapidity of the cut-off already limited by the small relative travel. The relative velocity of the cut-off valve attaining its highest rate when the cut-off valve is in its neutral position in relation to its seat, a valve with no lap will effect the cutting off at this period. But as the rapidity of the closure depends not only on the velocity of the valve at the moment of the cutting off, but also on that preceding this moment, it is clear that a negative lap will give better results. The time for the closure of the port will obviously be shortest if the valve has a negative lap equal to one-half the width of the port; for the velocity of the valve is then greatest when the port is half closed. But it must not be lost sight of that in this case the velocity is falling off towards the movement of the cutting off, and hence the negative lap should never be much greater than one-quarter of the relative travel; for else this reduction is greater than desirable. Hence the negative lap should not exceed one-half the width of the passage of the main-valve, nor should it be much in excess of one-half the shortest distance of O from the curve $q'Q°q''$ (Fig. 73).

But there is still another factor limiting the admissible extent of the negative lap; for negative lap may render possible a second opening of the ports of the main-valve before the latter closes the steam-ports of the cylinder. A brief consideration will, however, show that such an occurrence will be prevented if the negative lap of the cut-off valve is less than the outside lap of the main-valve; for at the grade of the earliest cut-off the passage of the main-valve will be opened at the point $OA°$, which is found by sweeping the lap-circle from the mate of the point q'. This line can evidently not be in advance of OE unless the negative lap of the cut-off valve exceeds the outside lap of the main-valve.

The valve is sometimes made of two plates rigidly fastened together by a yoke, or of a plate with a rectangular opening, the inside edges performing the cutting off. The cut-off eccentric is then placed behind, not ahead, of the main eccentric. The demonstration relating to Figs. 72 and 73 can be applied to Fig. 74, but instead of the points $q'Q°q''$, their upper mates are used in Fig. 74 as centres of the lap-circles showing the cut-off, for a reason explained in the foregoing chapter. The curve of ideal eccentrics has been determined in Fig. 74 by supposing the fulcrum to be on that side of the link *from* which the crank is rotating, in order that an *increase* of the angular advance be attended by an *increase* of the travel. The peculiarities of the valve-gear are now considerably changed, and a very early cut-off is not attainable except at the expense of the rapidity of the cutting off of the later grades. An improvement can be effected by using either no lap at all or even positive lap, on the cut-off valve. For although this measure is prejudicial to a free admission of steam, as it reduces the port opening of the cut-off valve for intermediate grades, the adoption of positive lap permits a

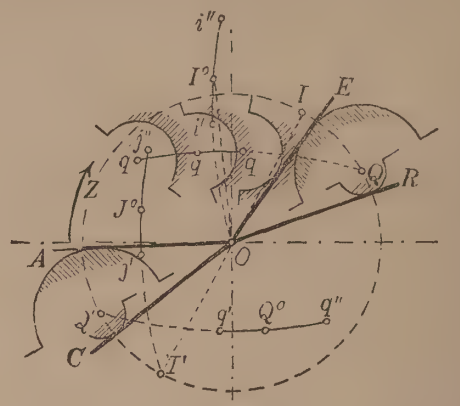

Fig. 74.

change of the angular advance of the cut-off eccentric to favor this shortcoming. The most advantageous lap can easily be found by a few trials, as will be shown hereafter.

This valve-gear admits of various modifications. The fulcrum of the cut-off link may be a fixed point, and the cut-off eccentric rod may be attached to the link-block, while the cut-off valve-stem is worked from a fixed point of the link; or the eccentric rod may be joined to a fixed point of the link, and the valve-stem may be worked from the link-block by a radius-rod in the manner of the Gooch link motion. In the former case a change of the grade involves both an angular change of the eccentric rod and a change of the absolute travel of the valve; in the latter case a change of the travel only is attainable. In the first case the ideal eccentrics will again form a curve, which, however, will not be a circular arc, and should, therefore, be constructed from the angle of advance, and the absolute travels of the cut-off valve due to various positions of the link-block. In the second case the ideal eccentrics will form a straight line, to the detriment of the sharpness of the cutting off at intermediate grades.

(To be continued.)

Petroleum.—Less attention is perhaps given to this wonderful product than to some of inferior rank and importance, and it is possible it is because its production seems to be of a phenomenal character and liable to serious interruption. The fact that this useful liquid flows to the surface of the earth through wells, as water rises from its springs, seems to deprive it of its position as an article of immense value in our export trade, or rather to give it a rank in our productions of dubious and uncertain character. And yet for twenty years petroleum has found its way to the surface of the earth, and the supply seems inexhaustible. In this or that locality the production diminishes, but new developments are constantly taking place, and the "third sand" is succeeded by a fourth, and cross belts come in to vary the experience of all explorers, and to puzzle the brains of geological professors and students.

During the last year the developments on Bullion Run have added greatly to the oil product, and quite recently a new belt, extending easterly from Millerstown has been added to the range of discoveries. Millerstown and vicinity, which three years since, produced about one-third of all the oil brought to the surface, has gradually reduced its yield, and it had been generally supposed that the days of this oil centre were numbered. Recently, however the explorers have tested with success an extension of the area easterly toward the Alleghany River, and the consequence is that the "east belt" is added to the "fourth sand" or cross belt, as something at variance with the views of experts, but satisfactory enough in development to excite testing processes and speculative experiments.

From recent publications in the *Derrick*, we find that in September, 1876, the price of crude oil was $3.50 to $4 per barrel, and the daily production 28,533 barrels, while the average daily shipments were 35,855 barrels.

The total exports from January 1 to October 1, 1876, were 173,078,236 gallons, and the stock above ground, as shown by the gauge committee, was 3,164,384 barrels.

In September, 1877, the price of crude oil was $2.30 to $2.40 per barrel, and the daily production 38,930 barrels, with average daily shipments of 51,912 barrels.

The total exports from January 1 to October 1, 1877, were 228,765,122 gallons, and the stock now on hand, as reported by Babbit, was 1,991,345 barrels, and as shown by other reports, 2,550,000 barrels.

These figures illustrate the rapid growth of the oil consumption and the magnitude of the trade. An increase in the exports during eight months of this year of 55,686,806 gallons gives us a fair idea of the importance of the product in our export list.—*Railway World*, iii, 987.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Age of the Sun and Earth.—There has been a long dispute between physicists and mathematicians on the one hand and the geologists and biologists on the other, as to the age of the earth, or rather, since that is equally involved, the age of the sun. Dr. Croll, the distinguished Scotch geologist, has recently offered a theory which is not altogether new, but admits of some novel arguments, and which may serve all parties to the dispute. Beginning with a review of the different theories as to the sun's heat, he rejects the combustion theory as totally inadequate, since if the sun were all a mass of burning coal, it would not last over 5,000 years; the chemical theory does not prolong the duration sufficiently; the meteoric theory will not serve; the only remaining explanation is the gravitation or consideration theory. This supposes that the materials of the solar system were originally a nebula, extending through a space many times greater than the orbit of Neptune. The falling together, the condensation of this amount of matter, it can be mathematically shown, would supply enough heat to keep the sun at its present temperature for 20,000,000 years. Unfortunately, that period is not sufficient for the geologist. He demands at least 100,000,000 years for the changes of the earth's surface, and would prefer twice that length of time. The arguments of the geologist are almost unanswerable; those of the biologist who believes in evolution tend to the same point so far as they go. Professor Croll says that there is a way out of this difficulty, by supposing that the nebula was not cold but hot. If you suppose it hot enough to start with, you will have heat enough to carry you through. Obviously it is just as easy to suppose a hot nebula as a cold one. But Professor Croll proposes to provide for this original heat. If the solar system had originally consisted of two masses, each of half the density of the whole, at some immeasurable distance apart, and they fell foul of each other owing to the mutual gravitation, they would strike with a speed of 274 miles per second. If their motion was stopped by the concussion, an amount of heat would be developed sufficient to convert the whole into a nebula that would take 50,000,000 years to cool. This is decidedly an improvement on the cold nebula. But this supposes that the component halves, before they started on their way to a collision, had no motion. Let us suppose that they were moving beforehand at the rate of 202 miles per second, and that this speed was added to what they got by gravitating toward each other; then we get, when they struck, a nebula extending beyond Neptune, and with heat enough for a sun of 100,000,000 years' duration. If you insist upon 200,000,000, you must give the original masses a speed of 676 miles per second, beforehand. It will be objected that no such motion has been observed in space. Even the planets do not make such fast time; the earth, for instance, going only a thousand miles in a minute. The fixed stars whose motion has been ascertained travel very much slower. But Professor Croll says the fixed stars are those that have gone through the collision process, and have lost their motion. The new hypothesis goes behind the ordinary nebular theory in point of time, giving an explanation for the formation of the nebula. But it presupposes that there may be vast, cold, invisible masses of matter rushing through space with such velocity that their mere touch would convert our globe into red hot gases and distribute it through infinite space. The conception is not incompatible with the sudden flaming out of a new star and its conversion into a nebula, as seems to have been the case with the Schmidt star in Cygnus; but the facts in that remarkable case were probably not known to Prof. Croll at the time his essay was written.—*N. Y. Tribune.*

New Method of Preparing Oxygen.—According to a Belgian photographic journal, Herr Zinno has discovered a new way of preparing oxygen in large quantities. Beric peroxide and potassic permaganate are placed in water and allowed to act upon one another, the result being that 200 cubic centimetres of oxygen are evolved from every gramme of the mixed substances.—*English Mechanic*, xvi, 136.

The Action of Light on Tellurium.—M. Siemens has noticed that light modifies the electrical resistance of selenium, and has upon this fact based the construction of a new photometer.* Phenomena of this kind are little studied, and but little is known as regards the sensibility of metals to light. Experiments have shown that tellurium possesses the same property as selenium, only the action is less intense. M. Boernskein has experimented with other metals, and has just published a note to the philosophical faculty at Heidelberg. He finds that the same property is possessed by platinum, gold, silver, and probably by all the metals.—*Revue Industrille*, viii, 418.

*See article on "Late advances in the science of Photometry," REVIEW, vol. iii, page 52.

Utilization of Blast Furnace Slag.—In a paper read before the Iron and Steel Institute at Newcastle, Mr. C. Wood gives a description of the variety of products made by the Cleveland Slag Co. at Middlesbrough. Slag bricks for building purposes are made from a mixture of slag sand, produced by a slag sand machine at the blast-furnace, selenitic lime (Scott's patent) and iron oxide. This mixture is pressed in a machine specially designed for that purpose, and the bricks made are allowed to dry for six days, after which they are exposed to the weather to harden. They are uniform in size and thickness, are cheaper than ordinary red brick and run a thousand less to the ton. From a mixture of slag sand, common lime and iron oxides, an hydraulic cement is manufactured which is but little inferior in strength to Portland cement, although 75 per cent. cheaper in price. Concrete made from this cement mixed with a little shingle produced from the rotary table, has been successfully used for heavy blast engine foundations and for the walls of buildings. Extensive experiments have been made to produce glass, according to the method of Mr. Eashley Britten, by taking the molten slag in a ladle from the blast furnace and pouring it into Siemens furnace, where certain amounts of carbonate of soda and silica are added. They have proved successful, and works are building at Findon, Northamptonshire, for the manufacture of glass bottles. At certain of the glass factories of the Western States a somewhat different course is to be pursued. The slag will be granulated and used as sand, though the amount of lime it contains will render necessary the use of less in the glass pots.—*Metall. Review*, i, 244.

Electric Light.—The s.s. *Faraday* while moored at Gravesend, previous to her voyage to America, was illuminated at night time by the electric light which she carries.

The apparatus for producing the light is of Messrs. Siemens' construction, and known as the "Dynamo Electric Light Apparatus;" it gives an intensely brilliant light equal to from 4,000 to 6,000 normal candles.

A separate steam engine is placed on the deck to drive the apparatus, which absorbs about 3 HP when the light is burning.

The electric lamp, which is also of Messrs. Siemens' invention and manufacture, was placed on the port-side the bridge, so as to throw a light over to the shore, and enable the boats attending on the ship to work with perfect safety throughout the night; the advantage and success of these night operations was proved beyond a doubt.

The light was so brilliant that persons on shore at a distance of over a quarter of a mile from the ship, could read ordinary writing with perfect ease.

While at sea, the lamp is placed at the mast head, and in this position it also gives very satisfactory results.

A vessel carrying so powerful a light is better able to sight any distant objects on dark nights, and she herself can be clearly seen by other ships, thus the electric light, besides enabling loading and unloading to be done at night, also provides a ship with a better safeguard against collision, and admits of her entering with safety any port or harbor by night as well as by day.—*Telegraphic Journal*, v, 246.

Phosphorescent of Sulphate of Quinine.—If some sulphate of quinine is strewn over a sheet of smooth paper and exposed to a heat of from 120° to 140° Fahr. by means of a plate of metal, it becomes phosphorescent when stirred with a glass rod. Valerate of quinine exhibits the same phenomenon without heat being applied, if the crystals are rubbed in a mortar. It said that the appearance is only noticed when the valerate contains an acid prepared directly from the root of valerian.—*English Mechanic*, xxvi, 136.

—A new process has been applied in Belgium to the manufacture of artificial black walnut, by which ordinary wood has imparted to it the appearance of the most beautiful specimens of walnut, adapted to the very finest cabinet work. The wood, first thoroughly dried and warmed, is coated once or twice with a liquid composed of part by weight of extract of walnut peel, dissolved in six parts of soft water by heating it to boiling, and stirring. The wood thus treated, when half dry, brushed with a solution of one part by weight of bichromate of potash in five parts of boiling water, and, after drying thoroughly, is rubbed and polished. The color is thus said to be fixed in the wood to a depth of one or two lines, and, in the case of red beech or alder, for instance, the walnut appearance is most perfect.—*American Builder*, xiii, 263.

Cement upon Iron or Stone.—A cement made of glycerine and litharge hardens rapidly, and makes a durable cement upon iron or stone. It is insoluble, and is not attacked by acids.—*American Builder*, xiii, 252.

A Cement for Attaching Brass Work to Bottle Necks, Lamps, &c., is made by boiling three parts of resin with one part of caustic soda, and five of water. The composition is then mixed with half of its weight of plaster of Paris. It sets firmly in half to three-quarters of an hour. It is said to be of great adhesive power, not permeable by petroleum, a low conductor of heat, and but superficially attacked by hot water. Zinc white, white lead, or precipitated chalk may be substituted for plaster, but hardens more slowly.—*Engineer*, xliv, 261.

Professor Barff's Process for Preventing Corrosion of Iron is looked upon by the Warden of the Standards as likely to prevent the oxidation of standard weights made of iron. Professor Barff has undertaken to submit some specimens of iron weights to this process, and it is intended to place these weights in the hands of some local inspector of weights and measures, so that it may be ascertained whether iron standard weights thus protected could safely be used in place of the expensive bronze or brass standard weights at present used.—*Engineer*, xliv, 261.

ENGINEERING—CIVIL AND MECHANICAL, &c.

Continuous Railway Brakes.—A valuable report was recently forwarded by the Belgian Government to the British Board of Trade, on the subject of continuous railway brakes. The Administration of the State railways in that country, fully aware of the importance of obtaining the best available means for the control of trains, have since a long time given a fair trial to various systems of brakes which promised to give good results. Experiments were conducted with the Achard, Masin, Heberlein and others, which however were thrown aside, and careful attention was given to the system which in 1873 appeared the most perfect that had yet been introduced. This was the Westinghouse atmospheric brake, which had previously been tried in this country, and which has long been working with excellent results upon the Metropolitan District Railway. The experiments with this system showed, as might have been expected, a superiority as compared with the hand brakes of about 3½ to 1. The experimental trains passed into regular service, and showed consistently their efficiency and reliability. The defects of the system, were, however, fully appreciated by the Railway Administration, the chief one being the delay that arose in bringing the brake into action. On the other hand, they equally appreciate the advantages it possessed, and which they summarized under the following heads: 1. Comparative promptness of action. 2. The facility of gradual application, and the fact that the driver of train could control the brake. 3. The distribution of elastic pressure on all the wheels throughout the train. 4. Its applicability to every wheel in the train. 5. Its non-liability to derangement. 6. Its action being independent of the motion of the train.

Between 1873 and 1875 financial reasons prevented any further adoption of the system on the part of the Belgian Government, and in the course of that year the new form of brake perfected by Mr. Westinghouse, and known as the Automatic, was submitted to the Administration, and, at the same time, another system which had also been acting, brought into notice—the Smith vacuum—was submitted to the consideration of the Belgian railway authorities. It was therefore decided to disregard the various other systems which showed more or less promise, and to confine attention in the new series of experiments, solely to the automatic and vacuum brakes. Accordingly two similar trains were fitted with these apparatus, and a number of carefully conducted experiments were made with them, and which are recorded in the report. The comparative results obtained corresponded very closely with those deduced from similar trials in this country, but it will be noticed that with neither brake did the stops made approach those attained on the North British Railway. It is to be regreted that the times occupied in making the stops are not recorded in the report. It will be noticed, also, that all the experiments were made at low speeds, so that the respective capacities of the two systems were not by any means developed as they have been in this country. Still, as will be seen in the report, the results were so decidedly in favor of the automatic brake as regards its promptness and efficiency, that the Committee reported unanimously in favor of its adoption, and acting on this view, the Administration has accepted the Automatic as the Standard brake throughout all the State lines, and its application will be commenced immediately. The Committee are also unanimous in their conclusion that the system they have proved to their own satisfaction to be so superior to the vacuum brake, that they recommend it in spite of the greater cost, will prove far less expensive in manufacture and working, than the latter, and they take pains to point out, that judging from the short

experience obtained, and from the nature of the brake, that the apparent advantage in first cost is "more deceptive than real, the cost of maintenance being higher for the Smith brake than for the Westinghouse, either automatic or atmospheric;" while the quantity of steam required to work the first-named is greater than for either of the other two, and therefore the cost of each stop is made greater.

The Belgian Government in taking this prompt action in the brake question, are to be congratulated upon the selection they have made. Whatever may be the drawback to having the railway system of a country vested in one central Administration, such an arrangement has, at least, this advantage, that it is free from all the conflicting interests and opinions, which, in England, render concerted and uniform action almost, if not quite impossible. This is illustrated by the Government publication just issued containing the correspondence between the Board of Trade and the Railway Companies Association, in which the representatives of the great lines of this country all advance conflicting statements, relative to the efficiency of various brake apparatus.

We believe that a series of trials with continuous brakes is shortly to be carried out in Germany, under Government auspices, and we trust that they will be conducted in such a way as to develop to the utmost the full capacity of all the different systems competing, that is to say that the trials should be exhaustive, and made with similar trains, consisting of, at least, ten or twelve carriages. So far as this latter feature is concerned, we believe it has been the intention of the railway authorities only to fit up four or five carriages on each system, but it need scarcely be pointed out that so limited an application would fail in giving anything like conclusive or satisfactory results. —*Engineering Magazine* vol. xvii, 279.—380.

Progress of the St. Gothard Tunnel.—The advancement made at the St. Gothard Tunnel during the week preceding the last, was 33 m. at the Gœschenen, and 17.9 at the Airolœnd—a progress of 7.3 m. per day. During all last week the work at the Airolœnd wss interrupted by a terrible conflagration which almost completely destroyed the village.

The federal council has addressed a circular to the governments of the cantons interested in the construction of the St. Gothard Railroad, calling their attention to the sensible progress made in the construction of the tunnel during the fifth year of the work, as compared with the preceding years. The circular says that, excepting unforeseen obstacles, the tunnel will be completed in three years.—*Moniteur Ind. Belge.*, iv. 450.

MINING, METALLURGY AND MINERALOGY.

Siemens' Direct Process in the Production of Iron and Steel.—In a paper read at the recent Newcastle meeting of the Iron and Steel Institute, Dr. C. W. Siemens gave an account of the further progress of his process for reducing iron and steel at once from the ore, without the necessity of first forming cast-iron, and reducing the pure iron from that, as in the ordinary method. The direct process is the oldest method of reducing iron, and it used to be practised by mixing comparatively rich iron ore in powder with about 25 per cent. of its weight of pounded coal, and then exposing the mixture of the heat of a smith's fire for some hours, when metallic iron was formed, which, on being heated to the welding point, on the smith's hearth, could be forged into a horseshoe of excellent quality. When fluxes, such as lime or clay were added to the mixture they helped to rid the iron of adherent slag. This plan could, however, only be employed on a small scale, and with very pure ores, free from sulphur and phosphorus. The more elaborate plan of reducing to cast iron first, then "refining" and "puddling," has been hitherto found necessary in dealing with large masses of ore of an impure kind. The simplicity of the early process has much in its favor; the iron is of the finest quality, and it is not surprising that attempts have been made from time to time to revert to it; but the fact that only rich ores are applicable, the expense of requisite manual labor great, and that the fuel required should be charcoal, have stood materially in the way. Dr. Siemens conceived that the direct process could be carried out by help of the modern appliances for the production of intense heat, and the manipulation of large masses, and by the aid of an advanced chemistry. He had, in his regenerative furnace a means of producing the necessary degree of heat without the use of charcoal and blowing apparatus. He began experiments, and in 1873 described his results in a paper to the Iron and Steel Institute. He subsequently carried out his process on a practicable scale at his Towcester Works, in Northamptonshire, where he produces rolled bars by the direct process equal to Swedish bar as regards toughness and purity.

He has two modes of carrying on the process; one, by means of a rotary furnace, and the other by means of a stationary furnace. The first mode is suitable to the poorer ores, and the other to the richer ores. The rotary gas furnace charged with ore, fluxes, and reducing agents reduces the metal in about two and a half hours. The slag is the tapped, and the heat of the furnace, and the speed of rotation are increased to facilitate the formation of balls. These balls still contain about 30 per cent. of cinder, but the iron is pure metal, while the slag contains all the sulphur and phosphorus. The balls are taken out of the rotator, and the slag is hammered out of them as in the old refinery or charcoal hearth process.

In the stationary furnace the malleable iron forms as a thick skin on the charge or ore, fluxes, and reducing agents. This skin is drawn out, cut into bars, and finished off like the balls from the rotatory furnace by the hammer.

The "shingled" metal thus produced is good melting material for the open-hearth or Siemens-Martin process of making steel; but when the ores are rich and free from sulphur and phosphorus, Dr. Siemens further simplifies the process by adding hematite pig-iron to the batch, and causing fusion to take place in the reducing furnace itself. The steel so produced is equal in quality to that of the open-hearth process as now practised.

Metallurgy in Japan.—The following is quoted by *Engineering* from a thesis prepared by a Japanese student, graduated at a United States college: Iron ores are very abundant in the Japanese Islands. The chief ores are magnetic iron ore, specular iron ore, and brown hematite. The first is found in two varieties, one of iron grey color, and the other black. Masses of this ore in the state of magnetic polarity, generally called lodestones, are found in the eastern part of Nipon, Sendai, and Nambu. They are very highly esteemed for the steel manufacture, for swords and compass needles. Japanese furnaces are small in size and simple in construction, although the principle is the same as that of the blast furnaces used here and in Europe. The walls of the Japanese furnace are built with fire-proof clay, and sometimes with a few stones. The shape of the furnace is round at the bottom, having at one side an opening which is closed with a clay stopper. On the opposite side of the furnace wall, a little above the bottom, there are two openings, through which a continuous stream of air is passed in the furnace by means of a Chinese bellows worked by men. Before the ores are put into the furnace they are piled up in heaps with coal and calcined, or roasted, so that the water, carbonic acid, and sulphur may be expelled. The Japanese do not know the theory of the puddling process used in the Western countries, but the principle is exactly the same. The cast iron mixed with some sand and some iron scales is melted with charcoal heat in a furnace similar to that already described, and kept in this melted state for several days until the whole mass assumes a fluid appearance. The Japanese method of steel making is entirely different from those usually employed in Western countries. It is done in this way. They mix a certain quantity of pig iron, which contains too great a quantity of carbon, with a certain quantity of bar iron, which has too little carbon, and cover the mass with borax and smelt in a small crucible of fire-proof clay for more than a week. The borax is used to dissolve any impurities in the slag. When the metal is separated from the slag floating on the surface, it is taken out and hammered hard, and alternately cooled in water and oil many times. After the steel has been cast in that method, it is cemented and tempered. The method of cementing consists in covering thickly the hammered steel with a liquid mixture of clay, loam ashes, and charcoal powder. When this layer is dried the whole is heated red hot and then cooled very slowly in warm water. The steel is now ground on a whetstone. The steel thus made is not very elastic, but is very hard. The explanation is that either the Japanese do not understand the tempering process, or they are unable to remove entirely the impurities from the steel. I have often heard Japanese blacksmiths say that watch springs can never be made in Japan, for Japanese steel is not elastic. The Japanese take great care and time in steel manufacture for swords. For instance, for ordinary knives forging and cooling are to be done only four times, but for swords fifteen times. Copper is and will be the most important metal of Japan. It is found in almost every province. For roasting they have a furnace covered with a shed, provided near the bottom with several openings for the draught of the air. Five alternate layers of ore and wood are placed in the furnace and burned.—*Journal of Society of Arts.*

MISCELLANEOUS.

Geological Survey of Brazil.—Among the more important results so far accomplished by the geological survey of Brazil, has been the discovery of the existence in Brazil of of the silurian, Devonian, carboniferous, triassic, Jurassic, cretaceous and post-tertiary formations, all of them furnishing well-characterized fossils in great variety, and of which large numbers have been collected by the commission for its investigation, and for the purpose of distribution in Brazil and of exchange with foreign establishments. So far no well-defined tertiary has been found to exist in Brazil. The survey has also been very successful in its ethnological researches, especially among the kitchen-middens of Santa Catharina, Parana, Sao Paulo, Bahia, and the Amazons, the results of which have been announced in part, although much of interest yet remains to be published. The researches in the coral reefs have been made the occasion of securing numbers of marine animals, all of which add to the resources of the survey.—*Engineer*, xliii, 261.

The Ancient Ruins of Colorado.—A correspondent of the Worcester *Spy* writes as follows of certain highly interesting discoveries recently made by the Geographical and Geological Survey of the Territories conducted by Dr. Hayden:

"Prof. Hayden has given Southwestern Colorado a new interest, by discovering and describing the ancient ruins in that section and in Southeastern Utah. The fertile valley of the Animas was densely inhabited and highly cultivated by an enlightened race of people centuries ago. The ruins of the houses, corrals, towns, fortifications, ditches, pottery-ware, drawings, non-interpretable writings, etc., show that many arts were cultivated by these prehistoric people which are now entirely lost. Their houses were built of almost every kind of stone, from small boulders to the finest sandstone.

"The finest of these ruins, and the nearest perfect, are situated about thirty-five miles below Animas City, in a large valley fifteen miles long by seven wide, on the west side of the river. This valley has been covered with buildings of every size, the two largest being 300 by 6,000 feet, and about 300 feet apart. They are built of small blocks of sandstone, laid in adobe mud, the outside walls being four feet and the inside walls from a foot and a half to three feet thick. In the lower story are found port-holes a foot square. There are rooms now left, and walls for about four stories high are still standing. About the second story, on the west side, there was once a balcony along the entire length of the building. No signs of a door are visible in the outer walls, and the ingress must have been from the top, in the inside there being passages from room to room. Most of them are small, from eight by ten to twelve by fourteen feet, the doors being two by four feet. The arches over the doors and port-holes are made of small cedar poles two inches wide, placed across, on which the masonry is placed. The sleepers supporting the floors are of cedar, about eight inches thick, and from twenty to fifty feet long, and about three feet apart. A layer of small round poles was placed across the sleepers, then a layer of thinly-split cedar sticks, then about three inches of earth, then a layer of cedar bark, then another layer of dirt, then a carpet of some kind of coarse grass. The rooms that have been protected from exposure are whitewashed, and the walls are ornamented with drawings and writings. In one of these rooms the impression of a hand dipped in whitewash, on a joist, is as plain as if it had been done only yesterday. In another room there are drawings of tarantulas, centipedes, horses and men.

"In some of the rooms have been found human bones, bones of sheep, corn-cobs, goods, raw-hides, and all colors and varieties of pottery-ware. These two large buildings are exactly the same in every respect. Portions of the buildings plainly show that they were destroyed by fire, the timbers being burned off and the roofs caved in, leaving the lower rooms entirely protected. The rock that these buildings were built of must have been brought a long way, as nothing to compare with it can be found within a radius of twenty miles. All the timber used is cedar, and has been brought at least twenty-five miles. Old ditches and roads are to be seen in every direction. The Navajo Indians say, in regard to these ruins, that their forefathers came there five old men's age ago (500 years), and that these ruins were here, and the same then as now, and there is no record whatever of their origin.—*Pop. Sci. Monthly*, lxvii., 127.

Fish as Brain Food.—The belief that fish is specially adapted to feed the brain, and that fish-eaters are therefore more intellectual than the average, does not find much favor with Dr. Beard. He says that this "delusion is so utterly opposed to chemistry, to physiology, to history, and to common observation, that it is very naturally almost universally accepted by the American people. It was started," he adds, "by the late Prof. Agassiz, who impulsively, and without previous consideration, apparently, as was his wont at times, made a statement to that effect before a committee on fisheries of the Massachusetts Legislature. The statement was so novel, so one-sided, and so untrue, that it spread like the blue-glass delusion, and has become the accepted creed of the nation.—*Popular Science Monthly*, lxvii, 127.

A New Malady of the Grape Vine has made its appearance in Switzerland, where it has already done considerable damage in the vineyards. It is known as *blanc de la vigne*, or white-sickness of the vine, and is caused by the development of a mycelium which overspreads every part of the diseased vine. Recent researches, says *La Nature*, shows that the cause of this infection resides in the props used for supporting the vines; the germs of the parasite find a shelter in the cracks of the wood. They may be destroyed by saturating the props with a solution of copper sulphate.—*Popular Science Monthly*, lxvii, 128.

The Petroleum Industry in Russia.—The Russian capitalists who are working the petroleum wells are now laying down iron pipes from the wells to the Black Sea coast, where ships may be loaded by pneumatic pumps. It was recently reported that an American company had petitioned the government for a concession to work all the petroleum wells in Asiatic Russia. It was pointed out to the authorities, however, that the Americans are aware that Russian petroleum will enter into serious competition with American, and that this was an effort to paralyze the trade.—*Am. Manufacturer.*

MANUFACTURING AND INDUSTRIAL NOTES.

—Among the recent shipments to Europe by the Waltham, Mass. Watch Company was a lot of 200 stem-winding watches, on the order of the British government, for the use of conductors and engineers of one of the State railroads of India. This order was obtained by the London Agency in competition with foreign manufacturers. Business at the Waltham factory is very active.

—The Pyramid Pin Co., of New Haven, Conn., are very busy now. They have six pin making machines, which turn out 176 pins a minute, all complete from the wire, and six pin-sticking machines, which stick a paper of pins, containing 360, in the same time.—*Fancy Goods Record*

—A large quantity of the metal for cartridge shells for the Turks and Russians is made at Wolcottville, Conn., and the brass mill there is running night and day, making the general business of the town very good. The amount of war material which is being manufactured in this country for the European combatants is prodigous. Lately, the steamer J. B Walker sailed from New Haven for Constantinople with nearly $2,000,000 worth of munition and ammunition for the Turks.—*Iron Age.*

—The Pratt & Whitney Co., Hartford, Conn., are doing a good business in their manufacture of taps and dies under the Grant patent and their improvements. They manufacture, for hand and machine work, both the United States standard and the Whitworth (England) standard, and lately they have received orders of considerable extent for the Whitworth standard, a Georgia railroad company ordering a complete set for all their shops. The dies and taps made by the Pratt & Whitney Company are so constructed that they cut, at one operation, the rounded Whitworth thread just as well as the common V thread or the abased V thread of the United States standard. The company is building, for S. W. Green, Jacob street, New York, a double set of type setting and type distributing machines, 12 of each.—*Iron Age.*

—The Pittsburgh (Pa.) Locomotive Works recently completed 2 heavy freight engines for the Indianapolis, Peru and Chicago road.

—John Brown & Son, of Philadelphia, are putting in one new double-deck boiler of five feet diameter, and setting with the Jarvis furnace. There is a battery of thirteen other boilers in the same establishment, which are also being set with the Jarvis. The very rapid introduction of this device, in most cases the second and even more orders being received from the same parties, appears to be the most possible demonstration as to its utility and efficiency.—*Am. Manf'r.*

—The Baldwin Locomotive Works, Philadelphia, have received orders for three engines of 3½-foot gauge, for the Southern and Western Railway of Queensland, Australia. The engine constructed last spring for New South Wales, Australia, arrived September 12, and is probably in service by this time. There are two motors for a city railway in Havana, Cuba.

—The American Iron Works, Jones & Laughlin, Pittsburgh, in the 24th ward, still continue in full operation, employing over 2,000 hands.

—The Brooks Locomotive Works, at Dunkirk, N. Y., have sold four freight engines to the Chicago, Milwaukee and St. Pauls road, and have an order, in hand, for locomotives for the New York Elevated Railroad.

—The Cumberland Iron Works, at Bridgeton, N. J., have more work on hand now than at any time for several years past. The pipe mill is running night and day on orders from California for gas pipe.

—The Niagara Bridge Works, at Buffalo, N. Y., have just completed a riveted lattice bridge, 450 feet high, over Watkins Glen, on the Syracuse, Geneva and Corning road.

—The Mercer Rubber Company, at Trenton, N. J., have just completed an order from one of the largest steel spring manufacturers in the country, for over 5,000 pounds of rubber car springs. The springs are for use on a large order for cars now being filled by a Western car builder.

—The Howe & Jefferson Dye Works, at Jeffersonville, Ind., have recently had one of their boilers set with the Bryant & Young's setting, and are able to burn their waste dye wood products, and produce a large increase of steam.

—The Ohio Falls (Ind.,) Car Company have received a contract to build seventy-five box cars for a Northern narrow gauge railway. This will give employment to a number of mechanics for several weeks.

—The firm of Hotchkiss & Gaylord, Cleveland, manufacturers of machine, bridge, track, plow and elevator bolts, etc., have received heavy orders from Canada for bolts for railroad bridges. On an average they manufacture from 20,000 to 55,000 bolts a day.

—D. Giles & Co., Chattanooga, start their foundry with orders for over four hundred tons of pipe and castings.

—The Tennessee Iron and Steel Company, Chattanooga, have orders for merchant iron enough to keep them busy for some time time.

ANSWERS TO CORRESPONDENTS.

CONNECTION OF PARALLEL PLATES. (H. T. C., Waterford, N. Y.) The cut shows five modes. No. 1 has two angle irons; is

1 2 3 4 5

complicated, and the inside joints cannot be caulked. No. 2 is simple, but cannot be caulked inside. No. 3, with channel iron is excellent, but it is difficult to bend the channel iron around fire-box corners. No. 4 is simple, but too much of a mud trap. No. 5 is the commonest form.

LIG SHEAVES. (F. C., Bordentown, N. J.) We suppose that these are *lignum vitæ* sheaves,

MAXIMUM THICKNESS OF IRON TO RESIST ACTION OF FIRE. (C. & S., Pottstown, Pa.) We never yet saw boiler metal dangerously thick, nor do we think ordinarily proportioned rivet-heads in any peril at all. We will look the subject up, and if we find enough material to prepare an article on it, will do so. Have referred your letter to the Hartford Steam Boiler Inspection and Insurance Co., and shall not neglect the matter.

ADDRESSES OF MAKERS OF PUNCHING MACHINES. (W. E. J., Galt, Canada.) Our "Special Notice" Column has two makers' addresses. We will send marked copy of this notice to others who should advertise.

ACCURACY OF CALIPERS. (C. R., Norristown, Pa.) Ordinary vernier calipers are all well enough for standard sizes, but will not detect low spots at all, or lack of parallelism as well as ordinary "leg" calipers.

PROPORTIONS OF RIVETS. (C. J. R., Allegheny City). You will find the dimensions, on Fig. 1 of sketch, almost correct.

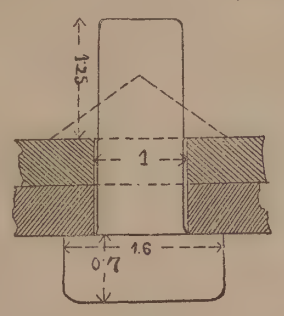


Fig. 1.

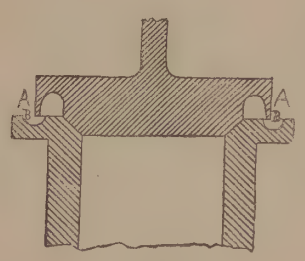


Fig. 2.

SAFETY VALVES. (J. F. W., Toronto). The "Richardson" valve, here shown, has a curved lip *a*, and a recess *B*, surrounding it. It is claimed that by this arrangement the recoil of the escaping steam gives a higher lip, and experiments. made by the U. S. Navy in 1873 show very favorably for it.

PROPORTIONS OF PUNCHING MACHINES. (W. E. J., Galt, Ontaria, Canada.) We could not lay down any general rule about the web in the throat, as asked. Put in all the metal you can afford, in the best shape you know how. Let no one part be weaker than any other, for the work it has to do. Our recent note on the power required to punch metal with various shaped punches, will enable you to calculate the work or duty of the punch, and the strain on any part of a throat of a given curve and depth.

WESTERN GUN WORKS. (A. T. H., Salem, Mass.) This establishment is a disgusting fraud.

HOT BOXES. (P. T. W., Pittsburg.) Try graphite—be sure that it is free from grit.

VALVOLENE. (S. E. C., New York.) We cannot express opinions of particular oils or other articles in these columns.

SEWER GAS TRAP. (P. H., Albany.) We think that hair, matches and such things as get into ordinary water-closet pipes, would stop your pipe up very soon.

WATER MOTER. (C. H. S., Utica.) We would suggest a miniature turbine for driving gas machines, &c., where water is too scarce to permit of using an overshot.

BIBLIOGRAPHIAL NOTICES.

THE POCKET GEOLOGIST AND BOOK OF MINERALS. Fred. H. Smith, Civil and Mining Engineer, Baltimore, Md. (128 pp. 12 mo.)

This work is intended to give to engineers and others unfamiliar with geology and mineralogy, such information of a practical nature, as may be useful in their professional work. It gives, in addition to a very concisely written chapter on general principles, much useful information concerning the several groups of economic minerals and the products obtained from mines.

BOOKS RECEIVED.

TREATISE ON ENGINEERING CONSTRUCTION. Embracing discussions of the principles involved, and descriptions of the material employed in tunneling, bridging, canal and road building, &c., &c., by J. E. Shields, C. E., with 44 illustrations. New York: D. Van Nostrand, 1877; 138 pp., 12 mo.

THE FATIGUE OF METALS UNDER REPEATED STRAINS, with various tables of results of experiments. From the German of Prof. Ludwig Spangenburg, with a preface by S. H. Shreve, A. M. New York: D. Van Nostrand, 1876. 89 pp.; 16 mo.

THE DESIGNING AND CONSTRUCTION OF STORAGE RESERVOIRS, by Arthur Jacob, B. A., late Executive Engineer for Irrigation, H. M. Bombay Service. New York: D. Van Nostrand, 1873. 95 pp.; 16 mo.

NEW CONSTRUCTION IN GRAPHICAL STATISTICS, by Henry M. Eddy, C. E., Ph. D., Professor of Mathematics and Civil Engineering in the University of Cincinnati. Illustrated by ten engravings in text and nine folding plates. Reprinted from Van Nostrand's Engineering Magazine. New York: D. Van Nostrand, 1877; 62 pp., 8 vo.

THE ELEMENTS OF GRAPHIC STATISTICS, by Prof. Karl Von Ott Translated from the German by Lieut. George Lydenham Clarke, Royal Indian Engineering College, author of "Practical Geometry and Engineering Drawing." E. & F. N. Spoon, N. Y.; 88 pp., 13 mo.

A PRACTICAL TREATMENT ON THE MOVEMENT OF SLIDE VALVES BY ECCENTRICS, for the use of engineers, draughtsmen, machinists and students in general, by C. W. MacCord, A. M., Professor Mechanical Drawing, Stevens Institute of Technology, Hoboken, N. J. Illustrated by eight full copper-plates. New York. 88 pp.; quarto.

PRACTICAL DESIGNING OF RETAINING WALLS, by Arthur Jacob, A. B., Associate of the Institute of Civil Engineering, late Executive H. M. Bombay Service. New York: D. Van Nostrand 47 pp.; 16 mo.

THE SANITARY CONDITION OF CITY AND COUNTRY DWELLING HOUSES, by George E. Waring, Jr., Consulting Engineer for Sanitary and Agricultural Work. New York: J. Van Nostrand, 1877. 145 pp.; 16 mo.

SELECTED LIST OF U. S. PATENTS.

195,466. VALVE-GEAR FOR STEAM ENGINES. A. J. Vandegrift, Covington, Ky.

The cut-off is actuated by a pendulum, which is caused to vibrate by the engine. Springs are interposed so that the vibration of the pendulum is in a measure independent of the reciprocation of the engine.

195,686. SHEDDING MECHANISM FOR LOOMS, H. Wyman, Worcester, Mass.

The shedding mechanism and pattern surface are connected to the shedding shaft in such a manner that the said pattern surface may be turned either forward or backward, and the shedding devices caused to operate in unison therewith, to form sheds independent of the other parts of the loom.

195,470. COP BUILDING MECHAW FOR SPINNING MACHINES. A. P. Adams. West Warren, Mass.

The cop is built up the same diameter from shoulder to shoulder by applying a building motion to the quadrant by means of an auxiliary cam connected to the rail, a builder nut and mechanism for operating the same, whereby the traverse of the rail is elevated at each reciprocation of said nut and its auxiliaries. The frame can be lowered when the machine is in motion by means of an arm and lever attached to a rock-shaft.

195,483. BUILDING PAPER OR BOARD. J. M. Cobb, Beloit, Wis.

This building paper is inodorous and water proof, and consists of straw board covered on both sides with a mixture of rosin and deodorized mineral oil, and calendered so that both sides of the board will present the same appearance, and have the same smooth, hard finish, and at the same time the board will be soft and pliable.

195,496. BREECHLOADING FIRE-ARM. B. O. Fasoldt, Albany, N. Y.

The cocking the hammer depresses the breech-block, and moves forward a spring-rod which operates the extractor. When the breech-lock approaches the limit of its downward movement, it bears upon the spring-rod, and unhooks it from the tumbler of the hammer, and allows it to be thrown back by its spring, giving the extractor a blow by which the shell is ejected.

195,501. PAPER BAG MACHINE. Thomas W. Grinter, Cincinnati Ohio.

The blanks have their bottom folds formed upon traveling tables, the upper surfaces of which have grooves in which moves an endless traveling presser band, which determines the line upon which the first fold is made. The tables in their forward movement engages with and carry along the reciprocating folding and pressing mechanism, which consists of a sliding folding bar, which enters the end of the blank, and after pushing it back into the diamond shape across the presser band, turns down upon it, thus assisting to press it flat when a second press-plate folds it down upon the blank and to the travel forward until near the paste-roll, when they are released by a cam upon the frame of the machine, and are returned to their original position ready for engagement with the next advancing table. From the paste-roll the crank passes to the curved folders, which gives the final bottom folds.

195,559. MACHINE FOR PUNCHING METAL PLATES. Stephen W. Baldwin, N. Y.

The plate to be punched is placed on the bed of the machine under a templet, which is provided with holes corresponding with those to be punched in the plate. The independent punches are placed in these holes, and as they are brought under the counter-sunk press-head they are forced through, falling beneath the machine.

195,659. PRODUCING HOT BLAST FOR METALLURGIC FURNACES. S. C. Salisbury, New York.

This apparatus consists of a hot-blast oven and a steam jet blast injector, whereby the air is sucked in and propelled through the oven without the aid of machinery. The feed pipe is laid in the waste heat space of the oven furnace so that the feed-air is heated before entering the injector. The steam pipe, properly jacketed, is also laid in the same waste heat space, another steam thereby superheated before reaching the injector. This apparatus produces a hot blast perfectly under control without the usual expensive plant of engines, boilers and blowing engines.

195,810. FULLING MILL. Rudoll Eukemeyer, Yonkers, N. Y.

The beater has a lifting-board attached to it and continuously driven lifting rolls, one of which is mounted upon a pivoted frame and a revolving cam-shaft, which intermittingly vibrates said frame, whereby said board is first compressed between the rolls, and the beaters lifted by their motion and then permitted to drop, the rolls meanwhile revolving. By means of this mechanism the rolls gradually bite upon the lifting-board, and lift the beaters by a smooth and easy motion. While the speed of the driving-shaft is uniform, the beater may be lifted to full height or to any lesser extent required, and the beats made more frequently and in proportion to the lift of the beater. Adjustable mechanism is provided to operate the vibrating frame with any required interval between the vibrations, whereby the lifting-rolls are made to engage with the lifting-board for longer or shorter period of time, according to the height required.

EDITORIAL CORRESPONDENCE.

The Patent Model System.

[The following contributions to the merits of the controversy respecting the present usage, regarding patent models, will be read with interest by a large portion of our readers. Both correspondents are gentlemen prominent in their profession, and their opinions are worthy of careful consideration. We have thought from the importance of the subject, and the desirability of speedy action on the part of "the powers that be," that the value of the matter to our readers would be enhanced by the simultaneous publication of letter and reply. EDS.]

WASHINGTON, D. C., Oct. 30, 1877.

EDS. POLYTECHNIC REVIEW:

I have just read in your issue of the 27th inst., the letter of Jno. Baldwin, and a reply thereto in relation to a proposition to dispensing with models in applications for patents. This is a matter of importance, and in view of the fact that strong efforts are to be made during the present session of Congress to effect unfriendly legislation on the subject of patterns, too much light cannot be thrown upon the various questions surrounding that subject. In the absence of models, the Patent Office must be furnished with full working drawings; for the law requires that the disclosure of the patentee shall be sufficient to enable a person skilled in that art to construct and work the device without further invention. This would be impossible if every part was not fully shown and prescribed. *In the absence of a model how can the solicitor prepare such drawings?* Clearly he must depend upon data furnished by the inventor. The solicitor, who, from sketches and such crude drawings as inventors usually are able to furnish, can venture to construct working drawings of a machine about which he never heard until yesterday, must have boundless intuition or —boundless cheek. It is difficult enough to avoid errors with a full working machine before one—it would be absolutely impossible to do so without better information than most inventors are able to furnish on paper.

A *very* large proportion of inventors are not mechanics, and a large proportion of those who are mechanics and who are fully able to read drawings, are utterly incapable of constructing working drawings. Yet if models are dispensed with, these men must either forego their patents, so thoroughly study the working drawings that no mistake in details are possible, or—make models.

Very few professional designers are capable of designing a machine of many parts so completely that no changes of detail will be required. How, then, can non-professional people be expected to accomplish this *every time.*

Supposing the models to be abolished, how much would be saved to the applicant?

In the first place, as models are usually constructed—built up piece-meal by the inventor himself—the cost is very much less than would be the cost of fully studied drawings. Secondly, the cost of reproducing these drawings for use in the Patent Office would be vastly in excess of the cost of *sufficient* drawings made from the model. Upon this point I have an experience which is, so far as I know, exceptional. I have directions from a client to take his models apart and prepare detail drawings of every piece. The models furnished by this gentleman are always miniature duplicates of his machines, and my experience has been that the cost of drawings, such as he orders, pretty nearly approaches the cost of the model. Without the model as a basis, the cost would necessarily be much higher, and then invariably they would include a dangerous element of uncertainty.

But the argument of greatest force is this: *the model comes from the inventor's own hands.* There cannot be any question that *it* embraces and illustrates the inventions of *his* brain; very often it has been constructed by his own hands—always under his own direction and supervision. The drawings and specifications are always the product of the hand and brain of another—a second-hand production; and it is manifest the chances of error or omission are infinitely greater in the latter than in the former case.

Unfortunately there are patentees who only desire the patent to trade upon. With them the importance of the invention or the validity of the patent are matters of small consideration. *Such* men would be glad to dispense with models. Unfortunately, also, there are solicitors who care as little for either of these considerations, and only desire the highest attainable fee for the amount of service rendered. Abolition of models would enable them—as it would compel us all—to enlarge *their* charges.

To the honest inventor, and to the solicitor who desires to do his duty conscientiously, there is no gain in dispensing with the models which will not be outweighed a thousand fold by the uncertainties which would be introduced thereby.

The absence of models will increase the cost of the official examinations. No man can read a machine from a drawing as quickly and accurately as from a model.

Without the model, it would be necessary to scrutinize every part of the drawing; with the model, only those parts concerned with the claim need to be examined. Without models, a large increase of the examining corps would be required. Upon this point I have made inquiries in the Patent Office, and the examiners are of the opinion that the absence of models would very largely increase their labors, *ergo*, it would necessitate an additional number of examiners.

The work of the office is not materially interrupted, because the examination calls up past inventions which the officers studied *while the models were in existence*, and the new cases have their models as before.

In reference to foreign systems, I can only say that the tendency is to assimilate their practices to ours. The new German law requires models as stringently as ours. In reference to the drawings in British patents, I can only say that some bear the marks of having been prepared from working machines, and those which do not are generally so indefinite and crude that no one could, with any certainty, reproduce the invention in machinery.

It is altogether a mistake to characterize as worthless that which, though obsolete, still marks a step in the history of art. Very many of the destroyed models represent distinctive inventions useful to-day. Very few of them represent inventions which were not useful advances in their time, and very many of them still continue their usefulness in other forms and new connections.

It would indeed be unworthy of a great nation like ours to plead want of space for the storage and exhibition of models, however numerous. The inventors of the United States have supported the Patent Office. They have supplied material for more than one *steal* of fair proportions, and they have in the treasury to their credit now about one million of dollars. Under such circumstances, the plea of *lack of space* is rather small. The inventors are willing to supply all funds needed to enlarge the space as fast as required. The Patent Office is the only bureau of the Government which *pays its own way*, and has never called upon Congress for a cent. It is time Congress should cease treating it as a pauper.

R. D. O. SMITH.

EDITORS OF THE POLYTECHNIC REVIEW:

Gentlemen—I am under obligations to you for advance sheets of a communication from a Washington Solicitor, in reply to my article in Patent Office models published in your last issue, and for permission to answer the communication in question, on perusing which my attention was first attracted to the italicized word *sufficient* in the following sentence:

"Secondly, the cost of reproducing the drawings (described as '*fully studied drawings*') for use in the Patent Office would be vastly in excess of the cost of *sufficient* drawings made from the model."

What meaning is to be attached to the word *sufficient* in the above connection?

Viewed in the light afforded by other parts of the paper, the author's meaning must be this, that a comparatively cheap and incomplete drawing, which in connection with a model, will *suffice* to illustrate an invention and, in connection with the specification, will be *sufficient* to instruct the Examiner, will not *suffice* for their purposes without the aid of a model, in the absence of which more expensive and "fully studied" drawings would be required. There could be no more forcible argument than this in favor of abandoning the model system.

The law requires that the specification of which the drawing forms a part, shall be sufficiently clear and exact to enable those skilled in the art to make the invention. The model is a matter *totally apart from the patent, which must not contain* any reference to the model, and in this connection it must be remembered that the law makes the requiring of a model optional with the Commissioner.

If a patent cannot be interpreted without the aid of the model deposited with the application it will be an invalid patent. If an attorney files an application, the drawings of which are so far from being "well studied" that the patent cannot be understood without the aid of the model, that attorney is imposing on his client.

Two reasons are advanced in the communication in favor of the continuance of the model system. One is that the models afford to attorneys facilities for preparing applications; the other is that they enable Examiners to perform their duties efficiently and promptly.

Let me attend to the second reason first.

It is stated by the author of the communication that he has conferred with the Examiners, who are of opinion that the absence of models *would very largely increase their labors.* For several years past, I have from time to time consulted Examiners on the subject, and in almost every instance they have stated that if *attorneys would file more complete drawings there would be less use for models.*

The two statements do not contradict each other, but go to show that with better drawings than usual, Examiners could dispense with models.

Any one who has had dealings with these officers must have noted their aptitude for readily understanding drawings; there are several Examiners who never look at the models. Of course the younger officers have this accomplishment to learn, but they acquire it in a very short time if they have any taste for the subject. All competent Attorneys, as well as Examiners, invariably prefer to make examinations from drawings.

It would be unfair in a few exceptional cases to ask Examiners to dispense with models, but I will venture to say that in twenty nine cases out of thirty an Examiner never wants a model if proper drawings "fully studied" are presented.

The other reason is that models afford facilities to Attorneys for the preparation of applications.

It is stated rather flippantly that "the solicitor who from sketches and such crude drawings as inventors usually are able to furnish can venture to construct *working* drawings of a machine about which he never heard until yesterday, must have unbounded intuition or unbounded cheek."

It is a little curious to note how persistently the author of the communication declares that *working* drawings will be required in the absence of models. Patents are not interpreted by reference to the models, but by the drawings attached to the patents, and if working drawings are essential to a proper interpretation of the patent they are essential whether a model has been deposited or not. It is not true that *working* drawings are required; what Examiners want are perspective with explanatory detached views and sections affording a full unmistakable display of the invention.

The drawings must be sufficient to enable a skilled draughtsman to make from them working drawings for the construction of the machine, and to enable Examiners to readily understand the invention; and these requirements should be complied with, whether there is a model or not.

It is as absurd to say that working drawings must be attached to a patent in the absence of a model, as to say that an inferior drawing may be filed when a model is used.

The Patent Offices of European countries do not require models; they rely on good drawings. It is a mistake of the Washington Solicitor to say that the German Empire under the new law demands a model with every application.

As to the increased cost of reproducing drawings which it is stated would be incurred in the absence of models, I have only to say that it costs no more to reproduce a good drawing than a bad one, by the photo-lithographic process.

It would seem that the Washington Solicitor cannot understand how proper drawings can be made from sketches such as inventors usually furnish; nevertheless the thing is done every day.

In different parts of the country attorneys and their assistants are in the constant habit of making drawings from crude sketches, and even from verbal descriptions. I know young men scarcely of age who can make the most complete drawings from the roughest diagrams, and who often examining a working machine can make a correct drawing of it by the aid of a few simple memoranda.

An attorney who could not perform duties like this in manufacturing communities would be considered unfit for his profession.

It may not be generally true as regards Washington practice, but it is nevertheless a fact that hosts of models are made under the instruction of attorneys and from drawings furnished by them —drawings made from the roughest of sketches.

In answer to the statement that "a very large proportion of inventors are not mechanics," I have to say it is the duty of an attorney to help these men by putting their inventions into proper shape, a duty which is constantly performed by attorneys or those employed by attorneys.

It is also stated that "a large proportion of those inventors who are mechanics, and who are fully able to read drawings, are utterly incapable of constructing *working* drawings. As a practical engineer who has worked among and has had charge of mechanics and has been engaged in mechanical pursuits for nearly forty years, I can say that there are very few mechanics who cannot make an accurate represention of an invention, rough perhaps, but amply sufficient to instruct a competent attorney.

Twenty or thirty years ago draughtsmen were scarce, and this scarcity might have afforded some excuse at that time for the use of models; but both mechanical and free-hand drawing have for several years past been taught in our schools, colleges, lyceums, workshops, &c., and now good draughtsmen are so plentiful that there is no difficulty in finding those who can make accurate well studied drawings from the most crude sketches.

The following quotation from the paper is worthy of especial notice:

"Unfortunately there are solicitors who only desire the highest attainable fee for the amount of service rendered. Abolition of models would enable them (as it would compel us all) to enlarge their charges."

This is a gratuitous insinuation that attorneys who want to abolish models are actuated solely by the selfish motive of looking for increased fees. As far as I am personally concerned, I will reply to this charge by saying, that as soon as models are abolished; as soon as I am relieved from the duty of instructing model makers; as soon as the delay consequent upon making models ceases, I shall be willing to reduce my charges.

"The abolition of models," says the Washington Solicitor, "would compel *us all* to enlarge our charges."

If it should compel attorneys to file more complete drawings, to abandon the practice of rushing through the office cases based on slovenly papers, the sooner models are abandoned the better will it be for the Patent Office, inventors, and the public.

If an inventor is not taxed with the cost of a model, he can afford to pay a reasonable price for carefully performed duties.

If an increased charge, however, is to be made by attorneys on account of the abandonment of models, it will be very like a tacit admission that the duties were not thoroughly performed when models were used.

Those who are opposed to the continuance of the model system do not wish to prevent inventors from making models and sending them to attorneys who cannot perform their duties without them; on the other hand, they do not wish the furnishing of models to the Patent Office to be compulsory in all cases, they do not wish to see whole armies of inventors taxed for the accommodation of a small regiment of attorneys, with its awkward squad.

That the abolition or partial abolition of models would have a salutary effect, I feel confident it would, with other advantages result in elevating the standard of mechanical, technical, and scientific attainments, and a little more of these qualifications both inside the office and among attorneys would be of advantage to inventors who have much more at stake in this matter than all others.

Models, as I have stated in a previous paper, may be necessary in a few cases; perhaps one cases in thirty may demand a model; in appeal cases they may be desirable, and in contested cases may be essential to the ready elucidation of difficult questions, but the terms of the statute show that the demand for models was not contemplated in every instance. Custom, however, has made the demand universal.

It is discretionary with the Commissioner whether a model shall be furnished or not with each application, but legislation will no doubt be necessary to enable him to make such ample and liberal provisions in the way of accessible drawings for the accomodation of inventors, as the abandonment of models will necessitate.

The public should have ready means of acquiring information relating to patents, and the model halls of the Patent Office afforded in a measure this opportunity.

Drawings of many of the classes have been already reproduced, and there is no reason why drawings of all patents should not be bound in classes for the ready perusal of inventors and attorneys. If this should be done, an examination of models would be rendered unnecessary, for the drawings afford a much readier means of acquiring information about patents than models.

This suggests another important question: if copies of all patents are made by photo-lithography it would cost but a trifle to so increase the number that the largest city of each State in the Union could be furnished with a complete set.

Public policy and justice to inventors suggest the propriety of making accessible in different cities and large towns, copies of patents, not bound in monthly volumes, as is now the practice, but in classes.

If the present model system be abolished and there is room to spare in the Patent Office, let it be devoted to such highly finished complete and accurate models of patented inventions as the makers are willing to deposit, and in a short time we shall have a national industrial museum, instructive exhibits in place of an useless accumulation of dummy models.

PHILADELPHIA, Nov. 5, 1877. H. HOWSON.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, NOVEMBER 17 and 24, 1877. Nos. 20 and 21.

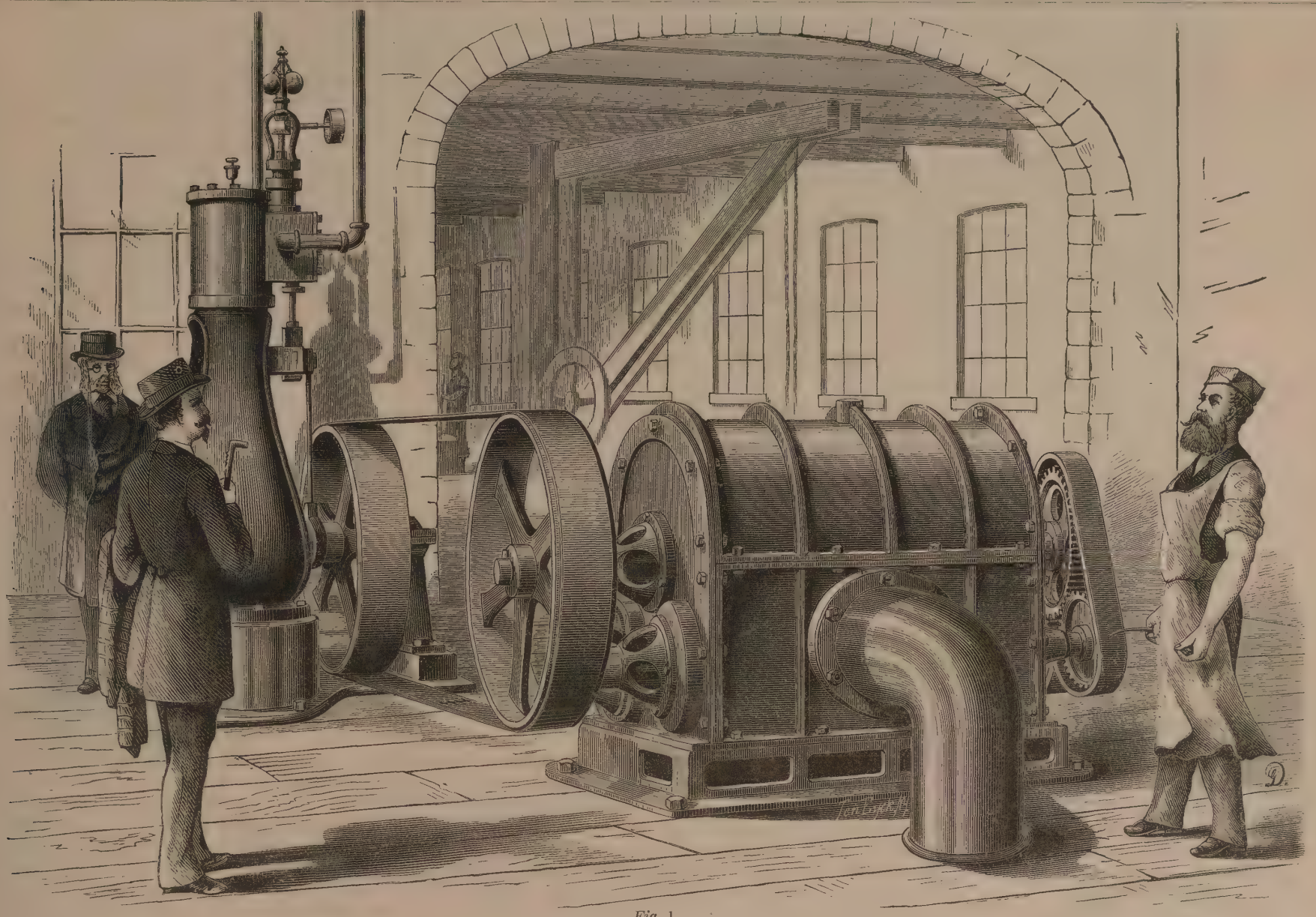


Fig 1.

THE BAKER PRESSURE BLOWER.

There are numerous contrivances built for the purpose of supplying blast under pressure, many of which possess the property of largely consuming the motive power, without showing a proportionate amount of work done. The principle involved in nearly all these machines, is that of rotation, excepting the old reciprocating piston blowers, now rapidly being superseded by those of improved patterns. The nature of the work to be accomplished generally governs the construction of the machine, so that usually we have a host of contrivances, adapted only to the requirement of specialty, and beyond which their utility is *nil*.

In a recent article,* we have spoken of the inferiority of the *fan* blower as compared with what is practically known as the *pressure* blower, and now we come to speak of a blower that is seemingly well adapted for all purposes to which pressure

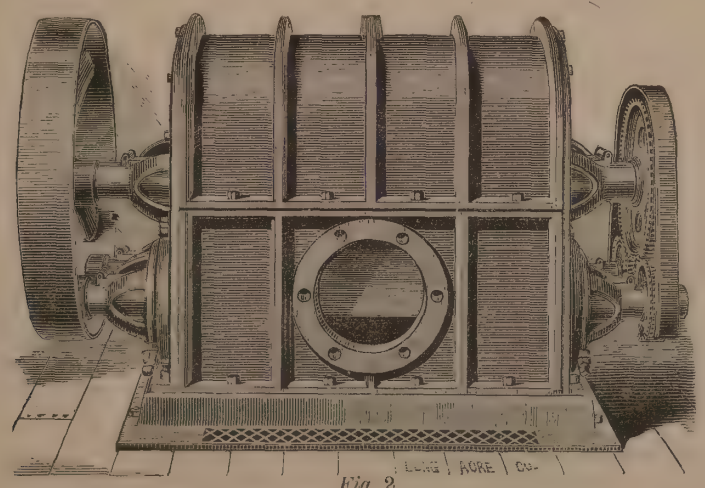


Fig. 2

blowing is applicable. The Baker pressure blower,† which we herewith illustrate, consists, essentially, of a cast-iron case, rectangular in plan and section, with a semi-cylindrical top, the whole being strongly ribbed.

The internal mechanism consists of a central cylindrical drum, (Fig. 3), provided with flanged wings which are securely bolted to it. These wings or arms, in revolving, approach very near to the sides of the casing, so as to be particularly air-tight in their rotations. Below the main drum, and at either side, approximating an equilateral triangle in arrangement, are two drums, running parallel to the main drum, and which serve as valves, each being provided with a crescent shaped abutment or back, the opening or slot in the rim being such as to allow freedom of rotation to the wings of the main drum. The three drums are connected by toothed wheels, placed on the end of the shafts external to the casing, the velocity ratio of the gearing being such that the smaller drums revolve twice as fast as the larger and in the opposite direction, each wing of the large drum necessitating a revolution of the smaller drums.

The external gearing is provided with a hood for security, while the opposite end of the main drum shaft is provided with a driving pulley. By the combined action of these drums, air is taken in at the bottom, at the atmospheric pressure, and forced through an opening in the side at a pressure directly proportional to the velocity of the machine ; or, referring to Fig. 3, the main shaft revolving in the direction of the arrow, causes the drums to revolve with double the velocity in the opposite direction, the wings at each revolution displacing the greater amount of air in these drums. In the figure, the upper wing is driving the internal air into the discharge pipe, the crescent side of the drum nearest the discharge being turned towards the opening, thus preventing the air from returning to the inlet while at the same time the crescent of the other drum is so placed as to form with that of the first a complete closure of the passage between the inlet and discharge. It is evident from the nature of the moving mechanism, that, whatever the position of the wings, any communication between the discharge and the inlet will be

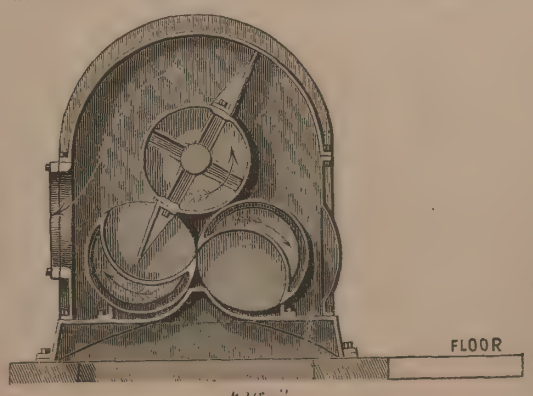


Fig. 3.

* Vol. iv., page 196, date of Oct. 27. 1877.

† Built by Wilbraham Bros. Manufacturers, 2318 Frankford Ave., Philadelphia.

prevented, either by one or both wings, and it will also appear that as the wings occupy but little of the internal space of the casing, the continuity of the blast must be perfect. Until quite recently, blower building has been attended by such defects as insufficiency of strength, multiplicity of parts and a maximum frictional resistance, while in the improved "Baker," the working parts are exceedingly strong, simplicity governs the construction of the machine throughout, and the friction may be regarded as almost *nil*, considering its proportions to the working capacity of the machine. The revolving drums are each cast in one piece, with their respective shafts in place, thus making a very substantial piece of work. Although working very closely in its internal movements, there is no point in actual contact, and the absence of any shrinkable material prevents the deleterious influence of dry or of moist weather, thus necessitating no replacement of internal working parts, nor disintegration of the machine for repairs. In certain textile processes, such as wool-drying, calico-drying, ventilation of mines and mills, the circulation of air currents is of the first importance, for which "pressure" blowing is especially adapted, and a blower that will *drink in flame* from an ordinary coal fire, at one side, and force it out at the other, irrespective of it becoming *red hot* meanwhile, and run for an hour or more under these conditions, is destined to occupy the first place among contrivances of its kind.

The Baker blower having accomplished this feat ‡ (an impossibility with blowers internally lagged with wood or composition), must be accorded this first distinction. Especially is this blower adapted to the blast of cupola furnaces, as its positive workings must ensure the forcing of a sufficient quantity of air through the tuyeres to prevent "clogging", and secure perfect combustion. The proper working of a cupola depends, not only upon the proper relationship between the diameter of the cupola, the arrangement of the tuyeres and charging hole, and the weight of the melted iron per hour, but also upon the proportion of air forced to the fuel consumed.

This latter is a very essential feature, for while a certain amount of fuel is necessary to melt a given amount of iron, so also is it necessary to provide the requisite amount of air to burn the fuel, as an excess or an insufficient quantity is highly injurious.

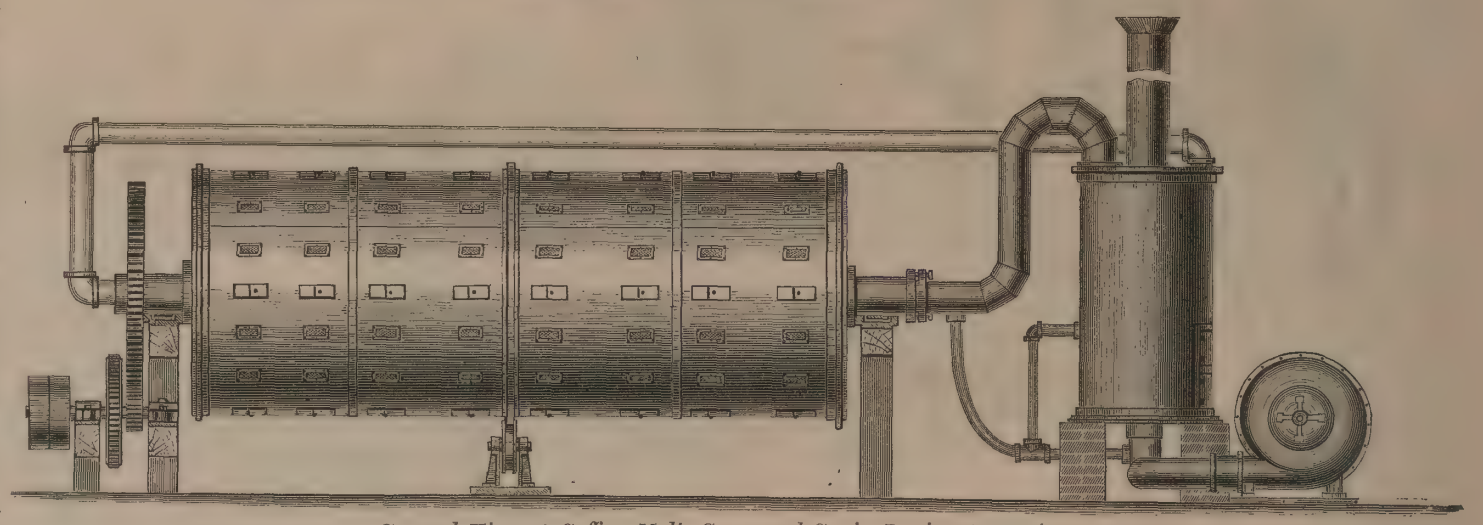
An excess of air above that necessary for the production of perfect combustion, or carbonic acid abstracting heat from the furnace in passing through, while on the contrary, an insufficient quantity would produce imperfect combustion, so that instead of the products of combustion being carbonic acid, a large proportion is carbonic oxide.

Owing to the different conditions existing within the cupola during the process of melting the iron, the blast must be of such varying pressure as to meet these various states or conditions. When the iron begins to melt, and the mass within the cupola assumes a pasty or semi-fluid condition, the resistance to the entrance of the blast is much increased, and consequently entails an increase in pressure of the air forced Consequently a blower of *low blast* power, would be unable to cope with these emergencies, and in this category must fall *fan blowers of all shades and patterns.* irrespective of their 50 per cent. *saving improvements.* It is here that the "pressure" blower displays its superiority over the fan, for as it is a *measurer* of air it is capable of delivering any desired quantity per minute. With a fan, the increased density of the mass, as it melts, throttles the outlet, and notwithstanding that the fan continues to run at practically the same speed, there is very slight increase in the pressure of the blast. An increase of pressure *may* be obtained by increasing its velocity, but this increase is out of all proportion to the power applied, and as in cases of this kind the speed with which the fan runs is such, that the centrifugal force generated tends to severally test the strength of the material composing it, and frequently the limit of rupture is reached.

Thousands of places, in all probability, could not be worked at all by human power, owing to imperfect ventilation, were it not for the means which artificial ventilation furnished, such, for instance, the deep workings of the Comstock lode, where various devices have been experimented upon, to furnish the mines with pure air, and to exhaust the hot and noxious atmosphere that usually attends the working of such drifts. It is in this mine that the Baker Blower has shown its superiority in competition with other blowing devices. S. F. P. JR.

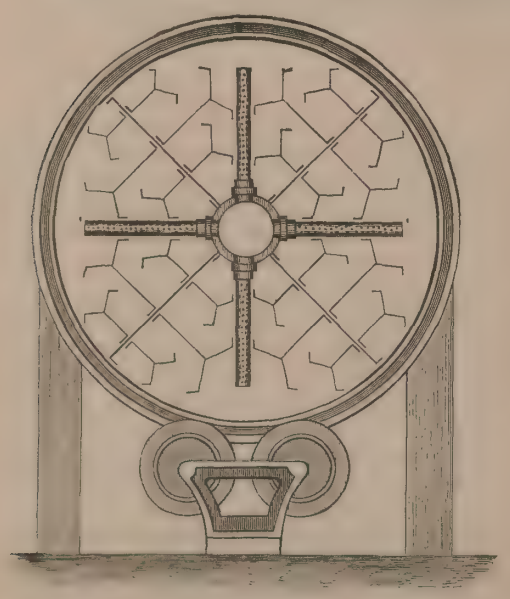
‡ Textile Manufacturers.

DRYING MACHINE FOR MALT, CORN, COFFEE, AND GRAIN.*



General View of Coffee, Malt, Corn, and Grain Drying Apparatus.

"Beer-making in the United States and in Europe is now carried on to such a large extent that the capital invested in it is figured by thousands of millions of dollars. The operation of drying the malt for the purpose of making beer is one of the most important of this great branch of industry. Kilns or drying-rooms of different forms have been devised, and machines of different constructions have been invented for this purpose; but up to the present moment very little progress has been realized, and every brewer and malster seems to be waiting for some new method or improvement that will bring the desired reform in the old routine. The present and general system of drying the malt is both expensive, tedious, and barbarous. We say barbarous in the sense of humanity. Men have to work in the drying-floors, under suffocating temperature, stirring and turning over the malt; of course this they do very imperfectly, on account of the steam and great heat that surround them and compel them to go out to breathe fresh air. The consequence is that part of the malt under treatment receives a greater amount of heat than another, and the grains are not all dried to the same degree. Malt dried under these unfavorable conditions will, of course, neither keep well so long nor make the same good quality of beer as malt that has been dried uniformly. Machinery has also been employed to stir the malt on these floors; but the work performed with this system does not seem to satisfy the maltster or brewer. In regard to the different machines invented heretofore for the same purpose, we can only say that they must have some important defects, otherwise they would have been adopted. That the kilns now in use are expensive, requires no demonstration. They are solid and costly buildings; and as the flues that convey the heat to the drying-rooms absorb a great quantity of the heat generated, the expense in fuel is very much increased. Very destructive fires have also had their origin in this primitive form of kilns. The time employed to complete the operation in the old kiln is also an objection. This depends not only on the amount of fuel and on the draft of the chimney of the furnace, but also on the construction and draft of the vapor shafts of the kilns; the combination and construction of these different parts are seldom perfect, and do not always give satisfactory results. To keep the temperature at the proper point, according to the degree of dryness of the grain, is also another very difficult matter in the old-fashioned kilns; and every one acquainted with the philosophy of drying grain knows that this is the most important part of this operation. Coffee (ripe as it is picked from the trees) has the same peculiarity as *wet* malt, both having about 50 per cent. of their weight of water to be evaporated. The same rational system adopted for drying malt is also followed in drying coffee—namely, to begin at a low temperature and increase this in the inverse ratio of the water remaining in the grain; beginning, say, at 100° and finishing at about 170° Fahr. In this manner the moisture of the interior of the grain is evaporated at the same time as that of the surface. This is said to be accomplished with the greatest perfection by this new apparatus. This machine is accompanied by a powerful heater of the same inventor. With this heater no smoke whatever can reach the drier. The air, in passing through a series of tubes, is heated to the required degree, and a blower forces it into the drying machine: it is there distributed by thousands of jets through the whole mass of the grain. A thermometer at each end of the machine indicates the degree of heat and saturation of the air passing through the cylinders. Blast-gates placed at the entrance of the centre pipe serve to regulate, in a moment, the temperature, in case of neglect of the attendant. The novel construction of the interior of this drying machine deserves particular notice. The cylinder is divided, *longitudinally*, in four parts, and in each of these four compartments are placed, *also longitudinally*, scattering plates, that distribute the grain in every part of the interior of the machine, and keep it in constant motion, when the cylinder revolves. Each grain then appears to have a life of itself, constantly moving and changing its position, The hot air is forced into the centre pipe by a blower. This pipe or hollow shaft is tapped at short intervals in the whole length, in each compartment, and has perforated radial pipes which insure a perfect distribution of the heated air throughout the grain. This hot air, in passing through the mass with the required velocity, absorbs gradually (according to its temperature) the moisture in the grain, and leaves at once through the perforations of the cylinder, showing in the beginning a vast cloud of vapor which disappears gradually as the grain becomes drier. A machine (the second made of this kind) like the one shown in our engraving (16 feet long by 6 feet diameter), recently built in this country, will hold and dry 300 bushels of malt per day. The rootlets of the germinated malt take up a great deal of room, otherwise the machine would hold a larger quantity. The same cylinder would hold about 350 cubic feet of coffee, corn, or wheat, leaving besides sufficient space for the grain to move about. Another feature of this machine for the brewer is, that the malt comes out perfectly clean, the rootlets falling through the perforated shell during the operation.



* *Elevation of a Cross-Section of the Interior of Drying Machine.*

Up to the present time, the same old routine is continued of drying coffee, cocoa, etc., in the sun. The heat that we get is certainly very economical, but, unfortunately, we cannot always depend on having fine weather. It often happens that during the crop we have heavy clouds and rains, and then the different increase, and the operation of drying does not progress: very often the planter suffers heavy losses through the fermentation of part of his crop. Besides, drying coffee in the open air requires a good many hands, and this causes sometimes delays in other branches of the business of the plantation. We must not forget that by this old system we lose, on an average, eight days; and as the sun cannot act directly and with equal force on every grain, the consequence is that all the grains do not dry evenly, a fact that is shown by the white berries that turn up when we clean the coffee. We must also mention the great cost of building these yards, and the value of the land they occupy, both of which represent a considerable sum."

*Patented by Jose Guardiola, Chocola, Guatemala. Made by C. Adolphe Lowe & Co., N. Y.

CHAIN BRIDGE OVER THE DNEIPER, AT KIEFF, RUSSIA.

"TEN MINUTE" PAPERS.

By Prof. J. E. Sweet.

TOOLS AND THEIR USES.—XII.

I believe there remains but one distinctive feature of the lathe to consider, and that is the tool-post. The conditions it ought to fulfill are various. It should hold the tool absolutely secure, both as regards vertical strains and side strain or such as tends to turn it around with the binding screw as a center. In the English practice they use two screws to hold the tool, which renders it more secure against twisting, but is no better, if as good, to prevent springing. So long as our practice of using one screw answers every purpose there is no shorter or better way. What is required to make a tool-post perfect is one in which the tool can be firmly secured in any direction and then raised or lowered in a nearly vertical line, quickly, and so it will be absolutely rigid. Of all the devices aiming to accomplish this end none of them quite fulfill all that is required. The New England plan of which our Washburn machine shop lathe is a good example, is quick to operate but too much is taken out of the swing of the lathe. It does not raise and fall vertically as it should and the plan does not admit of a solid bearing between the tool and bed. The Pratt & Whitney tool-post overcomes these three objections, but it is slow to operate, and when it wears loose, as it is liable to in time, then when raised or lowered it will have to be clamped to hold it firm. A tool-post on a similar plan is made by the Kidd iron works, of Rochester, in which the post is raised and lowered quickly by a coarse pitch screw, and made fast by a clamp device, worked by another handle. So far I think this as good as any of the class, but it requires two operations while one should accomplish it.

In Sellers' lathe the tool-post rocks over a pivot placed between the work and the operator. This leaves the lathe free for turning large cylinders; but the objection is that the adjusting screw has to be moved a long distance to effect a short movement of the point of the tool and the point of the tool does not move in a vertical line; beside when used for boring the rise and fall of the tool is so slight that great care is necessary in forging the tools. In this respect it is not so good as the Pratt & Whitney, and no better in any other. There are many other forms where the tool is made fast and can be raised and lowered afterward, one in which the post travels up and down an incline, another where it moves on the arc of a circle, but both plans have the objection that the point of the tool does not move vertically. If some unobjectionable plan can be devised to operate it, I think the reversal of the last plan can be made better than any of the others. Let the post be moved on the arc of a circle and the centre from which the arc is struck be level, or perhaps a little above and in front of the center of the lathe; see Fig. 17 No. X. When the curved block is moved the point of the tool will move vertically, the lathe will have a free swing and simply the turning of a handle will raise or lower the point of the tool readily, and to any reasonable extent.

Another method of adjusting the point of the tool is by two rings. Sometimes these rings are made thick at one edge and thin at the other, so that when the two thick edges of the rings are both placed under the inner end of the tool it is elevated to its highest position, and when next to the operator to its lowest and thus by shifting them around into any intermediate position the required height is obtained.

Another form is one employed by E. & A. Betts, in which the rings are notched in an ingenious manner, whereby a great variety of changes can be had, and yet the tool has a level seat to rest upon.

Another plan is one used by some of the Fitchburg builders in which a spherical gib is introduced between the bottom of the tool and a concave washer, by sliding this gib endwise the point of the tool is raised or lowered.

The plan we have been using on the Amateur lathe is the reverse, that is, the gib is concave on its lower side and rests upon a spherical washer. It has two advantages over the other plan. The bearing surface is nearer at a right angle to the pressure and as a consequence less liable to slip, while the convex surface of the washer does not catch the chips and dirt. None of these latter devises are however comparable to those in which the tool can be made fast and tilted or raised in position afterward.

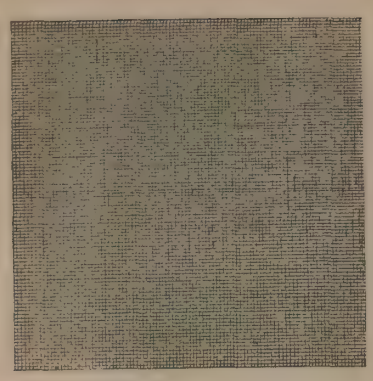
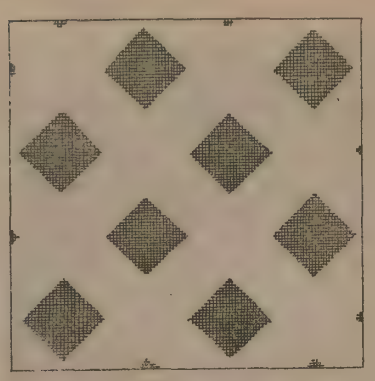
In connection with the tool post is the arrangement used by all the best lathe-makers for gauging the position of the tool in cutting screws. Stops have been devised in various forms, but none that I have seen are as good as that on the Pratt & Whitney, because it is the only one in which there is nothing to put on or take off, It is only necessary to tighten a screw and it is ready for either inside or outside work.

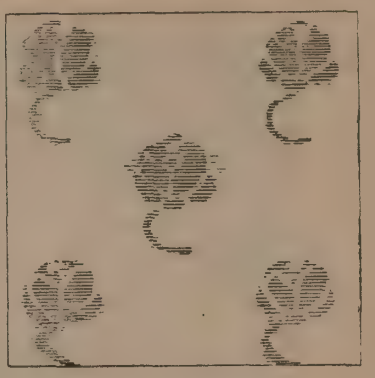
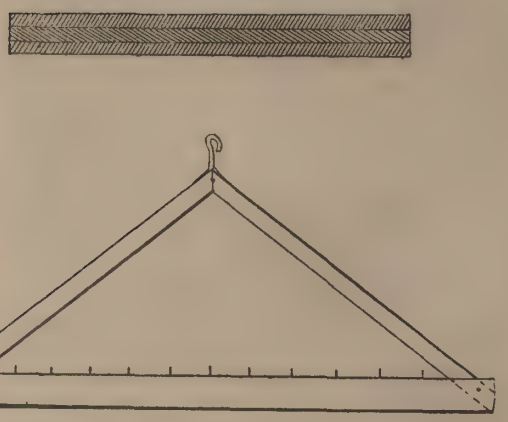
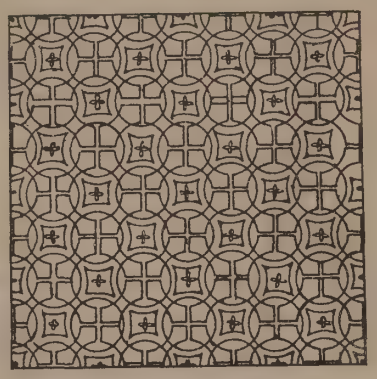
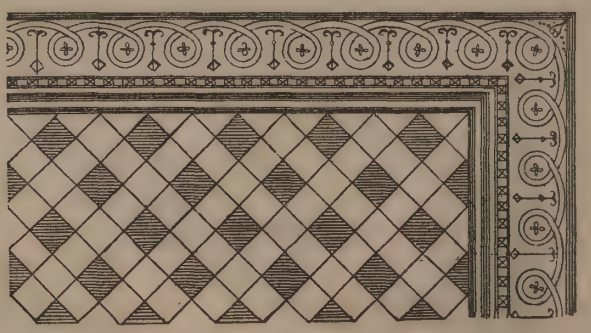
Another method of accomplishing the same thing is that used on our Amateur lathe by which the tool-post is drawn back a short distance and returned to its place, without disturbing the cross-feed screw. This I have seen done better than in our lathe and the devise can be advantageously applied to all lathes except such as have the cross slide removable. The devise was applied to a lathe built by Wm. H. Craig. of Syracuse, and though the mechanism was simple, consisting of three additional pieces of steel only, it is somewhat difficult to describe. Its action, however, is easily described and worked as follows: Two movable stops are adjusted on the front side of the lathe-bed, similar to the stops on a planer-bed, when the point of the tool is brought to the point where it is desired to have the thread terminate, then the stop at the head-stock end is set in such a position that the end of a sliding bar that moves freely through the slide-rest will come in contact with it. The sliding rod being brought to rest with the slide-rest still in motion, an incline one the sliding-rod forces out the nut through which the cross-feed screw travels. In running the lathe-back the other end of the sliding-bar coming in contact with the other stop properly arranged reverses the operation. By the ingenious construction of this sliding bar it could be quickly changed so as to work for both right and left hand screws and nuts. This devise proved applicable to more purposes than was contemplated, and valuable in a way not thought of at first. The point of a screw cutting tool is broken off more frequently at the finishing point of a thread than elsewhere, and this drawing out the tool accurately by the action of the lathe overcomes this trouble. The saving in this respect more than pays for the whole devise every year.

Again by introducing formers in the place of the sliding-bar, irregular shapes can be turned as perfectly as cylinders, and the same former that will turn a proper anti friction curved bearing will bore a box to a perfect fit.

Having thus endeavored to consider all the different parts of the engine lathe and reasons why certain arrangements ought to be better than others: it does not follow that those features deemed the best can be combined in one machine, or that if they were so combined that the finished lathe would be better than some now built. Still the attempt to combine them will be a good study for some of you and will call for more thought than you are likely to suppose.

*Read before the Mechanical Engineering Association of Cornell University, N. Y.

THE MANUFACTURE OF OIL CLOTH.

The interest taken by the public in the articles in THE POLYTECHNIC REVIEW, descriptive of various branches of manufactures not generally familiar, and their very general reproduction by our contemporaries, warrants us in placing before our readers a description of oil-cloth making, as carried on at the establishment of Messrs. Hunt & Co., Salem, N. J.

The oil-cloth, so called, as used for floor covering, consists of strong jute cloth, (called "burlap") covered with mineral colors ground in oil. The burlaps are imported from Dundee, Scotland, coming in rolls from 3 feet to 12 feet wide, and about 150 yards long. (It is greatly to be regretted that this branch of manufacture is not carried on more largely in the United States. The city of Dundee has over 50 mills; from which the burlaps are sent all over the world—even to Calcutta, whence the raw jute is sent out.) The burlaps weigh from 9 oz. to 12 oz. per square yard. Their open texture must be filled up, and a smooth, heavy ground color put on before the reception of the pattern. For best quality goods, from six to eight coats of ochre and whiting, ground in linseed oil are applied. The ochre comes from Pennsylvania, the whiting from England. The cloth for third quality goods is "starched" with a glue size as a priming coat, receiving afterward several coats of oil color. The "painting machine" is primitive in construction, but rapid and effectual in operation; it is used for either starching or grounding with oil. The 50-yard roll is attached by hooks to the base of a wooden triangle, and a rope attached to the apex of the triangle drags the roll through the painter and along a drying rack. The paint is applied with a dipper, and is spread by the cloth passing between an oil-cloth cushion and a steel knife edge, slanting in the direction of motion. Fifty lineal yards a minute can be printed; in all from eight to ten thousand yards in the various grades are daily printed in the whole establishment.

After each of the first four coats of oil-color, the goods must be "shaved," as the fibers of burlap make the surface somewhat fuzzy and uneven. The "shaving" machine has a table over which the cloth is passed (lightly stretched, while two bars each bearing two pumice stone "bricks" (or more according to width), scrub the surface with a longitudinal and traversing motion, imitating hand-scrubbing, An ingenious reversing friction device slackens up the tight roll to allow of its removal from the roller when "shaved.' The pumice stone rubbing gives a fine, even surface; and after the last ground coat, the pattern or color blocks may be applied. The blocks employed in printing are similar to those used in wall-paper printing, and illustrated in our issue of June 2d; being maple blocks, one cut for each color. These blocks are either in "peg"-work, line-work, or rule-work. The first are made by sawing the blocks lengthwise and crosswise with a circular saw (leaving square "pegs" projecting), and then cutting away those portions not intended to print.

The block is of maple, with a barking of pine laid both ways to prevent warping or cracking.

The line work has its design in parallel lines only. The brass or "copper" blocks have the design traced in the flat block. and then sharp brass rules driven in to the required outlines. Peg-work is repaired by driving in copper wire cut square at one end and sharp at the other. Line-work is repaired by brass rules driven in. The felt filling used between the rules of some wall-paper blocks is not here employed, as preventing proper impression. For mat-work the block embraces one-fourth of the pattern, and must be of such a character as to admit being turned to print successive corner quarters.

Patterns vary. This year mosaic patterns or imitations of marble are ordered; last year carpet patterns were in vogue.

The blocks are made in Hallowell, Maine, near the starting-point of the oil-cloth industry in this country.

In printing, the "press" is simply a table having pins to gauge the distance along which the cloth roll must be passed after each section is printed. The color-pads are rested on a "whirl table" with vertical axis, in front of each press; each pad has before it a pail of oil-color, with distributing brushes. The table is whirled to bring the pad and block to the front as needed. The blocks have handles on the backs; each one is laid face downwards on the pack, then on the cloth, then returned to the pad. After all the single color impressions have been given, one block, called the "masher," which has no color applied to it, and which has on it the whole pattern, is applied, and and given a strong impression by means of a press consisting of an overhead traveling device, with a vertical rod and a screw-cam. This last impression is not used in wall-paper making. A sample of the mixed color used with each block is preserved in a cup marked with the number of the pattern; hence at any time a pattern can be exactly imitated to order. After printing, drying is in order, and should last at least 10 days. The older oil-cloth is, the better, as the paint hardens. "Dryers" injuriously affect the linseed oil; air drying is preferable, but the American market cannot afford it. In England, a piece of oil-cloth is frequently six months in making; here it is generally but thirty days. The heat is graduated to 130° F., running up from 90°. There are two buildings, used alternately for printing and varnishing and drying.

Printing with rollers has not yet been introduced, except into one establishment in New York; but it is merely a question of time.

The principal pigments employed are vermilion, drop black, Venetian red, Sienna, chrome yellows, white lead and umbers.

After printing and drying, varnishing is in order, copal varnishes being sprinkled on the roll and distributed by two vibrating arms, each bearing five soft brushes. The roll is handled by means of the triangle and drag rope, and hauled through and into the drying racks.

The establishment visited employs about 60 men, under the management of Mr. S. W. Dunn, and turns out each week about ten thousand square yards of finished oil-cloth. G.

THE SPIROPHORE.

This instrument, devised by M. Woillez for resuscitating asphyxiated persons, and particularly those who have been in danger of death by drowning, is claimed to be superior to all other methods or appliances employed for such purposes. It consists of a sheet iron cylinder, large enough to receive the body of an adult person. This cylinder is enclosed at one end and the body of the patient inserted, feet foremost, at the open end, up to the neck, round which a diaphragm is placed in such a manner as to prevent air from entering the cylinder. An air pump is then set to work; the air is drawn off from the cylinder, with the result of causing a partial vacuum, when the outer air by its weight forces itself into the lungs through the mouth and nostrils, which are exposed to the external air; by an opposite action of the pump the air is allowed to re-enter the cylinder, and respiration is thereby imitated. A glass plate inserted in the cylinder enables the operator to watch the movements of the chest, which rises and falls, as in life, with the alternate working of the pump; these may be repeated about eighteen times a minute, and an exact imitation of natural breathing is thereby effected.—*N. Y. Tribune.*

A STRONG CEMENT.

The so-called crystal Porcelain cement consists, according to Prof. Böttger, of gelatine dissolved in acetic acid. It is prepared by placing a small piece of clear gelatine in a porcelain cup, and after adding a small quantity of acetic acid, slowly heating it until a viscid, perfectly homogenous jelly is formed, which on cooling forms a transparent mass. In order to cement two broken parts together, the gelatine-like mass is returned to a fluid condition by gently warming, and applied by means of a brush to the fractured faces; the latter are then gently pressed together, and permitted to lay quietly for twelve or fourteen hours.—*American Journal of Microscopy*, ii, 160.

BEARINGS OR BRASSES AND JOURNALS.

BY JOSHUA ROSE, M. E.

It is somewhat astonishing that so much difference should exist in practice in the manner of fitting bearings to journals, especially when it is considered that the theory pursued in England is the direct opposite of that adopted in the United States. In a great many instances bearings or boxes are not fitted at all, but are put to the journals just as left from the boring. Now let me first show that such a bearing can only run well from the merest accident. It is a practical fact that if we take a pair of brasses, or any bearing composed of two halves, it cannot be bored round, and that the hole will always be fonnd to be less in the diameter measured across the joint than if measured from crown to crown. The reason of this it is not necessary to explain; but anybody can satisfy himself of the fact by gauging a pair of carefully bored brasses or boxes. If in chucking the brasses to bore them the joint faces were left open to take up the wear, they will fit more nearly to the journal than if they were made a butt joint, that is to say, if the faces were close together; but in either case the crown of the brass will not bed to the journal; and the result is that when the journal is at work under its load it will touch only a small area of the brass; and the whole load being thrown upon that area will cause it to wear rapidly, which is commonly called wearing or "working down to a bearing." During this process, however, the surfaces of both the journal and the brasses will wear in rings, instead of having that glossy, mirror-like surface, indispensible to a good bearing. The rings may be fine, but they exist; and when the brass wears to a fit, which they will rapidly do, it is rough instead of smooth, and the surfaces will continue to abrade, producing undue friction, if not a bearing that requires constant watching to prevent its heating. Under these circumstances not only is an undue quantity of oil used, but it is not uncommon to lay all the blame upon the oil. Sometimes a bearing of this kind will, in time, right itself by gradually wearing to a smooth surface, and this generally occurs when either the duty upon the bearing is light, or else when the area of the journal is large in proportion to the duty. If the kind of oil used happens to be changed at about the time the journal and bearings commence to wear smooth, the new oil gets the credit; while on the other hand, if a journal has a good smooth and ample bearing area, an inferior oil will be found to answer very well for a time at least.

To obviate the defect of the brasses boring oval, and to save the trouble of fitting them properly with a file and half-round scraper, it is customary with some to adopt one of two plans, that is to say: if the brasses come close together at the joint, a piece of tin is placed between the joint faces, and the brasses are bored the thickness of the piece of tin too large; but if the joints of the brasses when finished are intended to be left open, so that they may be keyed up to take up the wear without the trouble of filing the faces down, then the hole is bored too large in the proportion of about $\frac{1}{32}$ of an inch for a bore of 8 inches. The result of this is, that the brasses are sure to fit down upon the crown; but the faultness lies in the fact that it is guess-work, and may give the journal room to roll back and forth in the bearing. Furthermore, the bearing is sure not to be even over the contracting area, but harder at some parts than at others; and it is unquestionable that the surface will, in that event, wear rough and in lines of rings, and so important is absolute smoothness in a journal that if a spot abrades or becomes rough upon a crank bearing, many engineers will take a hammer and chiser and chip the rough spot away and smooth it with a file, having found from experience that a rough place or spot is soon destructive to the smoothness of the whole journal; and having also found that it is better to entirely cut away the abraded spots than to file them even with a very smooth file; this practice is adopted by some of the most skillful engineers upon the fast transatlantic steamships. There is indeed nothing mysterious about the heating or undue wear of journals and bearings. If the metal is suitable, the bearing surface ample, the lubrication reasonably perfect, and the brasses are *properly fitted*, the bearing will run, from the very first moment it is put in perfectly smooth and without any extra attention or even watching. Experience with properly fitted journals demonstrates this beyond the possibility of doubt; and there are mechanics who could no more expect a journal to run hot, than a piston or main shaft to break.

The great consideration in fitting a brass to a journal is, that the bearing between the surfaces shall have equal contact, and that the brasses shall properly fit to the box or strap containing them, and so long as this is the case, the oil will not be so readily pressed out from between the surfaces, and there will be no undue pressure tending to cause any part of the bearing area to wear unsmoothly. It is contended, however, that a bearing properly fitted at first will not remain so after it has worn sometime, and as this theory vitally affects both the form and fitting of bearings, and is the groundwork of a wide difference in practice in the manner of designing and fitting them it is well to examine into its merits.

Suppose that *Fig.* 1 represents a pillow-block, the brass being properly bedded in the block and fitted evenly to the journal. The bottom brass beds upon the surfaces *A B C*, and the top brass is held down by the contact of the surface *D* with the cap *F*. Now the pressure upon these surfaces *A*, *B*, *C* and *D* compresses them (so that after the brasses have been sometime in use, any marks upon the block or the cap will be plainly impressed on the brasses), and it follows that from this compression those surfaces are stretched or expanded, or tend to stretch, and although the form of the surfaces *A B C* is such as to prevent their length from becoming elongated, yet the metal in their neighborhood is expanded and finds relief in closing the brass across the joint, as denoted by E. This is the theory, and certain it is that the brasses do in time become slack in the block across the diameter denoted by *G*. Now the brass is the weakest across the diameter *G*, the disposition of the metal not being such as to give strength in that direction, and as a result the stretching of the metal around *A B C* causes the brasses to bind unduly upon the journal at and near the joint as denoted by the dotted segments of a circle H. To prevent this the brasses are filed away at that portion of the bore of the brasses (and on each side of the joint) denoted by *H*; and whenever the brasses are found to touch on that surface it is filed away in all cases, even though as in the case of locomotives, the thrust upon the journal is in the direction denoted by the respective arrows *J J*. It will be noted also that the wear upon the bore of the brass removes the metal which otherwise might, by also stretching from the pressure, tend to keep the brass from closing across the diameter at E. The amount to which this closure takes place depends, to a certain extent, upon the thickness of metal between the bore and the outside of the brass where it fits the box. I have known cases, such as shown in *Fig.* 2, where the joints of the brass having been left well open to allow of closing them up by the key to take up the wear, and the brasses not having been taken out for a long time, the other brass not having extended to a half-circle, the one shown in the figure had closed upon the journal, covering more than half of the journal's circumference, and had to be driven off with a sledge hammer the sides of the brass having altered from the form, denoted by the dotted lines, to that of the full lines in the figures.

Fig. 1.

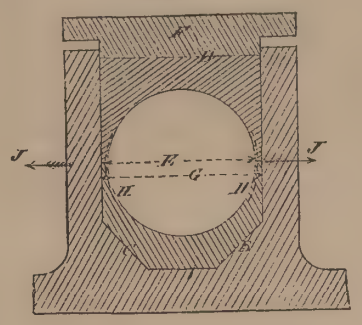


Fig. 2.

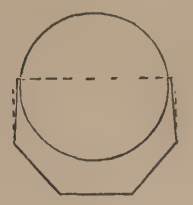


Fig. 3.

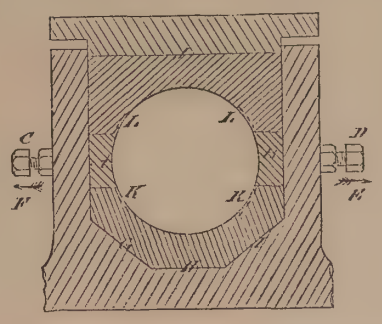
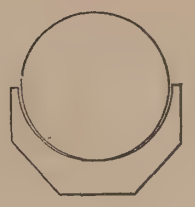


Fig. 4.



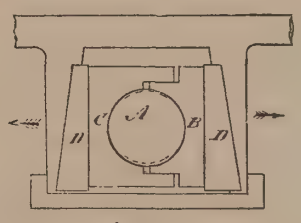


Fig. 5.

In the other system referred to, the brasses or bearings are made in four pieces as shown in *Fig.* 3, the two pieces *A* and *B* being set up to fit the journal by means of the set screws *C D*. The object of this arrangement is to have a bearing upon the journal in a direction to directly resist the thrust of the shaft, that thrust being in the direction denoted respectively by the arrows *E* and *F*. In this case the brasses will have contact with the journal all over the area of the bore, which so far as the amount of area goes is an advantage, but it premises that the curve of the brass is not sufficiently operative to prevent the bore from wearing oval; or in other words, that in the absence of *A B* the brasses would wear as shown in *Fig.* 4; whereas, such is not in the case of locomotives at least, found to be the case.

Furthermore, the pressure and stretching of the metal of the brass at *A B C* in *Fig.* 1, or at *G*, *H*, *I* and *J* in *Fig.* 3, will cause the brasses in *Fig.* 3 to close upon the journal, to some extent, at and towards *K K* and *L L*, or in the attempt to do so, to bind in those places unduly upon the journal, destroying the smoothness that is essential to durability and to the absence of undue friction. The setting up of the pieces *A B* in *Fig.* 3 also requires very skillful operation, as it is only by the resistance of the screws that we can estimate how much to set them in, and it is not uncommon to see an engineer, after setting them up, go occasionally to the bearing and feel if it is getting warm, if so, he slacks back the screws a trifle, or if there is a knock or pound he will set them in a little more. Now suppose, by being a little too tight, the bearing has heated; the probabilities are, a hundred to one, that the undue friction has destroyed the smoothness of the bearing, and then the excellence of the same is destroyed, and rapid wear and excessive friction will continue until the surfaces get smooth again, which sometimes is not until they have been fine filed all over, and even then they will not be so smooth (nor anything like it), as they become under proper wear.

In cases where it is necessary that the crown of the brass shall resist the thrust, it is better to so arrange the position of the pillow-block that the brasses will be in the necessary position, and then file away the brasses so that they do not bear at and near the joint; that is to say, each brass is filed clear of the journal in that part of its bore denoted by the dotted segments of a circle *H H* in *Fig.* 1. This plan is often resorted to, being decidedly preferable to the use of the pieces *A B* in *Fig.* 3. In some instances, however, this is impracticable, and in such an event the brasses may be put together in a manner adopted by Crampton about thirty years ago, and which is shown in *Fig.* 5, in which *A* is the journal, *B* one brass and *C* the other, the line of thrust in the respective directions being denoted by the arrows; the thrust being, therefore, resisted by the brass in the direction of the crown. The brasses, however, should be filed clear in that part of the bore denoted by the dotted lines, and left open at the joint as shown, were adjusted to fit the journals by means of the wedges *D D* set up by adjustable screws and nuts. The objection to this class of bearings or boxes it that the shaft must be taken out to get the brasses out when necessary. It is true, primarily, an expensive job to fit brasses or bearings to their journals. First, the bore requires to be filed out on each side until the brass beds fairly upon the crown the shaft must be put into place in the brasses and revolved back and forth to mark the high spots, so that they may be eased away with the file or scraper, the latter being used for the finishing processes because it leaves a more smooth and polished surface

than the file; the process being repeated until the marks show an even bearing all over. The fitting of the brass to the pillow-block and cap should be done with the utmost precision, otherwise the compression will in time alter the shape of the brass, causing it to bind unevenly upon the journal. With solid brasses and boxes it is an easy matter to ensure, by fitting, that the bearing shall be equal all over both of the brass to the block or bore, or of the brass to the journal; but in case of the employment of the pieces *A B*, in *Fig.* 3, it is almost impracticable to obtain a perfect adjustment of pressure, because if the screws receive the pressure due to the thrust their ends sink into the pieces *A B*, and frequent adjustment becomes necessary; any difference in the fit of the screw-threads tends to deceive; a burr upon one end of the threads has the same effect; furthermore, suppose there is a pound or knock in the box, what is to determine on which side of the box, block or bearing the screws should be set up, or how much is necessary on each side to keep the journal exactly central with the bore of the top and bottom brass, for no matter on which side we first adjust the screws they will move easily until the play is taken up, whether they are moving the journal either into or out of line with the brass bore. In fitting the bearings for oil-testing machines, the greatest of care is requisite in order that the surfaces may have an an equal area of bearing for each kind of oil, and that each oil may commence with a bearing having an equally smooth face. In fact, to obtain exact results, the bearings should be refitted to the journals preparatory to the use of each kind of oil, the bore being in each ease draw-filed in the roughing process, and scraped to a glossy, even process all over. No bearing is a perfect one, unless you can "see your face in it," as workmen say.

EXPLOSIONS OF STEAM BOILERS.

By JOHN W. HILL, M. E.

The alarming frequency of explosions, especially in the rural districts, demands that the attention of State Legislatures be directed to a speedy solution of the important problem of safety in the use of steam boilers. The interest of the public in a proper system of inspection of steam boilers is rapidly developing, and the necessity of such a surveillance of the manufacture and operation of this eminently useful but dangerous adjunct of civilization, as will reduce explosions to a minimum, is probably felt by all, however remotely interested in steam machinery.

What is required is the appointment of a Board of Inspectors in every State, to investigate and report upon every explosion, as well as to pursue a rigid system of inspection of the construction and use of steam boilers.

While it is not imagined that such a Board could enter upon their duties sufficiently charged with information to prevent all explosions in the future, their association with the work from year to year, and by frequent exchange of views with other similar Boards, would presently expand and develop their knowledge in a manner not to be attained by other processes.

It appears to the writer that the appointment of an Engineer with a selected corps of assistants, to inspect all boilers now in use and recommend legal measures for the prevention of disastrous explosions in the future, would be quite as desirable a "luxury" as the usual Geological corps, for whilst the labors of the latter may improve our knowledge of the physical structure of our respective increments of the sphere, and open up avenues to unexpected wealth, the labors of the former will save priceless lives, and property to the extent of millions.

That there are certain political objections to the inauguration of such a system, is admitted, but the combined wisdom of our State law makers should be sufficient to meet the "legal" and "moral" impediments to a rigid law, regulating the manufacture and use of steam boilers.

However this may be, no one who is a constant reader of the metropolitan daily papers, can doubt the necessity of a careful system of inspection of the materials and workmanship employed in the construction of steam boilers, and in the use of the boiler after it is set to work.

The great majority of accidents are not with boilers in the hands of men who, from the force of circumstances, are supposed to have a certain knowledge of the "regimes' to be established in operating a steam boiler, but with the rural steam users whose knowledge is naturally very "limited" and as naturally very "dangerous." Whether the frequency of explosions in the "country" is the immediate result of the appreciation of the dangers surrounding a seething boiler, or to impositions practiced on the unwary by knavish boiler makers, in furnishing poor workmanship and defective materials, is a question to be determined. That poor materials and workmanship are often the "prime" cause of disastrous explosions is well known, and however this may be, a system of rigid inspection, by competent officials in every State, would speedily bring the construction and use of steam boilers to the proper level.

The system of inspection should embrace: The form of boiler as affected by the water of the locality in which it is to be used; the variability of load, and the fuel to be burned in the furnace; the dimensions as affected by maximum capacity required; the thickness of plates, class of riveting and caulking, and quality of iron to be used as affected by maximum pressure under which the boiler is to be worked; the test to be applied to the iron used, and the tests to be applied to the finished boilers; the manner of heating and purifying the feed water and its introduction into the boiler; the style of furnace to be used and general arrangement for facility of inspection; the safety appliances and standard of tests for "steam gauges," "safety valves," low water alarms and other devices applied to steam boilers.

Every steam boiler now in use, and every steam boiler made in the future, should be subject to inspection, and a "seal" put upon it, and a certificate with restrictions under which it may be worked furnished the owner, tampering with the one or exceeding the other to be visited with a severe punishment.

In France, a manufacturer cannot put in use a steam boiler without a permit from the prefect of the department. In making an application for "license" to purchase and put to work a steam boiler, the manufacturer addresses the prefect on a government blank, furnishing the following information: Maximum pressure of steam under which the boiler is to work; horse power and class of connected engine; form of boiler desired; location of boiler in relation to buildings and public highway; fuel to be burned; nature of business conducted in the establishment, and plan of location (on separate sheet).

The prefect of the department refers the application to the prefect of the *arrondissement*, who in turn refers it to the mayor of the *commune*; this officer then proceeds to an investigation *de commodo et incommodo*. The investigation is continued for ten days; five days after its termination the mayor addresses the *proces-verbal* of the investigation, with his recommendation in the premises, to the prefect of the arrondissement, who transmits, with his opinion, to the prefect of the department. The prefect then lays the *proces* before the nearest government engineer who examines, and delivers an opinion upon which the decision of the prefect is based. This decree of 1810 (which as the writer is advised is still in force) in connection with an ordinance passed in 1843, relating to steam boilers, which provides that the boiler shall be tested—first at the shop where it was built, second at the establishment where it is to be used—by the nearest government engineer, who, after inspectiou, furnishes the owner a certificate of condition and restrictions, under which the boiler shall be operated. The tests are *obligatory* (except for mines), and give the manufacturer an *immunity* in the use of a steam boiler nowhere else approximated.

Under our system, or rather lack of system, the manufacturer buys and operates his boiler at his own option; if he desires to drive a forty horse-power engine with a twenty horse-power boiler, there is no law, so far as the writer is aware, to prevent his doing so.

The one great impediment to procuring a legal enactment relating to steam boilers, is the general indifference of the public to the safety of human life. Take the preceding instance: If, in carrying out the intention to drive a forty horse-power engine with a twenty horse-power boiler, the boiler "lets go," the public sympathy would be as great for the man who lost the boiler as for the men who lost their lives.

As an illustration of this, the writer would relate a circumstance happening several years ago:

A steam boiler, furnishing power to a very large agricultural machine shop, exploded with terrible violence, demolishing one entire section of the building, and killing and injuring several of the workmen; the writer, coming on the ground a few minutes after the explosion, saw the workmen carrying off the corpse of one of the victims. Shocked at the sight, and desirous of ascertaining the extent of damage to life and limb, he suggested to a bystander "that it appeared to be a very rough accident!" the response came in a suppressed tone, "It was rough on Smith, he would be obliged to buy a new boiler." In this instance six men were killed, and perhaps twenty seriously injured. It may not be out of place to remark that this was one of those rare cases where the engineer enjoyed the princely income "of six dollars a week."

In nearly every instance of boiler explosion, it appears that the usual legal investigation of the causes of the accident is a mere "farce," that neither determines the real or proximate causes, or locates the blame where it properly belongs; and whilst the facts usually adduced at the inquest, may form a foundati on upon which the experienced engineer can build a theory of explosion, it is in the great majority of cases simply absurd to base a legal verdict upon the opinion of men whose knowledge of the steam boiler is of the most limited kind.

Several years ago a small cylinder boiler furnishing steam to a "digester" in a large soap and candle works in Cincinnati, suddenly "let go," killing the attendant and one of the factory hands on the spot, while a section of the shell, weighing upwards of a thousand pounds, passed directly up two or three hundred feet, thence westward nearly a half a mile, and fell, killing three small children.

At the inquest, it was ascertained that no one but the attendant was to blame, and as he was already dead, the coroner "generously forebore to prosecute him;" at the same time the facts in this case, as related to the writer by the previous attendants of the boiler, were such as to have condemned the proprietors to several years penal servitude, under the "boiler law" of Prussia.

Coupled with the lack of legal inspection, the general location of boilers, in many of our large manufacturing establishments, is reprehensible in the highest degree. In the city of Cincinnati, there is a certain establishment, covering a superfice of 300 × 200 feet, and lifting skywards seven stories.

Each of the floors, except the basement, contains a small army of workmen, and thousands of dollars worth of costly matetials and manufactured goods in various stages of completion. In the basement, about as central as posts and stone pillars would permit, is located the battery of boilers furnishing the power to drive the machinery. Let us suppose an explosion in this case; what would be the probable results? Is it to be imagined that any large portion of the several hundred workmen shut up in this miniature Vesuvius would escape whole? By no means. Let the slender threads now linking safety to disaster, lose their hold, and the pent up volcano would burst forth, pouring human lava through the vents. Such an occurrence would fall upon the community like a mantle of darkness, and great would be the desire to locate the blame *somewhere*. The coroner would assume an air of marvelous concern, and swear by the party that put him in office, that the affair should be probed to the quick, and the fault brought home to its father, "though angels weep." To this end a jury would be struck, composed of distinguished citizens, with a plentiful *lack* of information upon the questions to be brought before them, who after the usual delays, would "on with the quest."

The picture may be highly colored, but the outlines are lifelike, as any one may verify who will read the testimony and verdicts of the inquests following appalling accidents.

The fall of the Dixon bridge, the breaking of the Mill River Dam, the Ashtabula horror and the late total demolition of the Rockford Court House, furnish excellent magazines of information upon the customary "legal" proceedings following these wholesale murders.

If we could have the inquest before the accident instead of after, how much better it would be; although this might seem "paradoxical" it is the spirit of the French law regulating the use or "steam boilers," and an explosion in that country *is a rare event*. —*Van Nostrand's Magazine for October.*

SINGLE FLUID BATTERIES*

The single fluid batteries are well adapted for use on what are termed open circuits—that is, circuits which are only closed occasionally and for but a few moments at a time. Some of the forms, however, answer an excellent purpose upon telegraphic or other circuits of great length or high resistance. They are also exceedingly convenient for experimental purposes, or, in fact, for occasional use of any kind.

The Smee Battery.—This battery was made upon observing the property which rough surfaces possess of evolving hydrogen, and smooth surfaces of favoring its adhesion. Thus, whatever metal is used for the negative plate is roughened, either by a corrosive acid or mechanically by rubbing the surface with sand paper. The liquid generally used to charge this battery is 1 part sulphuric acid to 10 of water. The form of battery used for telegraphic purposes consists of a strip of platinum, one inch wide by ten in length, fastened to a beam of wood, upon the opposite side of which is a plate of zinc covered with mercury, and both plunged into a glass vessel. In arranging a series of cells, the zinc of the one cell is attached to the platinum of the next. Figs. 16 and 17 represent the battery as formerly used in working telegraph lines. *A* is an in-

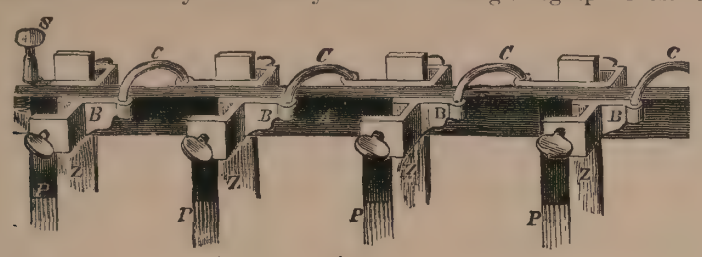


Fig. 16.

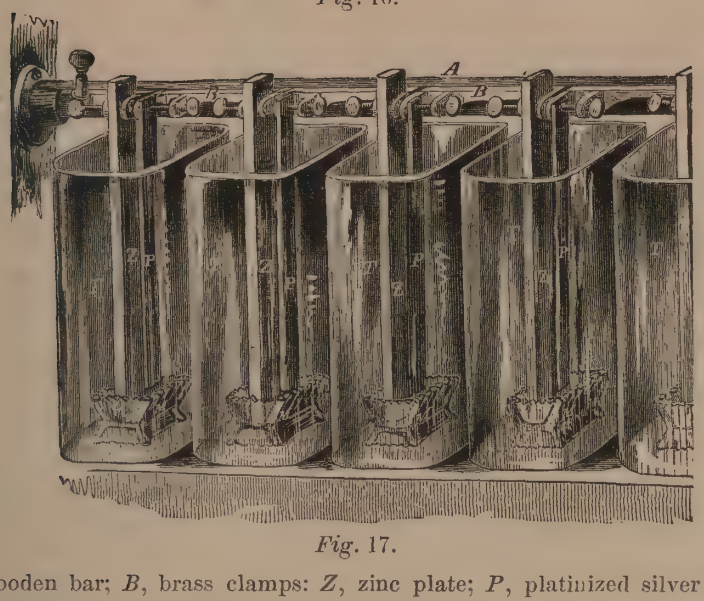


Fig. 17.

sulated wooden bar; *B*, brass clamps: *Z*, zinc plate; *P*, platinized silver plates or strips of platinum; *T*, glass cells. In fig. 16 the wooden bar rests upon the glass cells; in fig. 17 the bar rests on iron brackets fastened to independent supports.

The Leclanche Battery.—The + pole consists of a carbon plate which on its upper end is coated with rosin, and provided with a binding screw; it stands in a porous cup, which is filled with a coarse grained mixture, of the needle form of peroxide of manganese and carbon, the residue of gas retorts.

The — pole consists of an amalgamated zinc rod; both poles stand in a diluted solution of sal-ammonia, which is poured into the outside glass vessel.

When the element is closed the current in the zinc cup decomposes the water and the sal-ammoniac, and in the carbon cell the manganese. In the zinc cell chloride of zinc is formed, which dissolves; the hydrogen of the decomposed water is neutralized by an equivalent of oxygen which the manganese gives up; the hydrogen of the chlorine unites with the oxygen of the decomposed water. Hence the zinc, as well as the carbons always maintain a good conducting connection with the fluid, and consequently the strength of current upon circuits of considerable resistance remains constant for a long time.

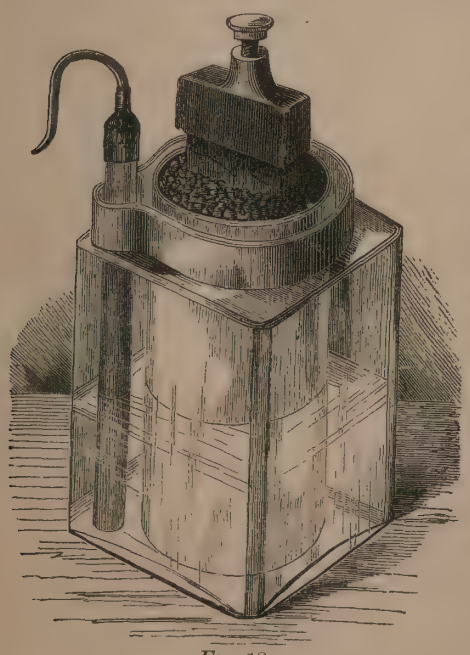


Fig. 18.

Leclanché's element has been employed for the past seven years on several French and Belgian railroads, and is also used elsewhere very successfully for telegraphic purposes, hotel annunciators, and so forth. The internal resistance of the element is hardly $\frac{1}{6}$th of that of a mercury element of the same size; while the electro-motive force of 25 cells is equal to 40 Daniell elements.

In practice, for every 50 grains of zinc dissolved, 100 grains of sal-ammoniac are consumed and 100 grains of manganese peroxide are reduced. There is no waste of material when the battery is not in action, so that, if the evaporation, of the liquid is prevented, it may be allowed to remain untouched for months without losing power. It is well suited for a telegraph wire not in constant use and worked upon the open circuit plan, or for electric bells. It is not suitable for permanent currents or local circuits, because when placed in short circuit it polarizes very quickly,

* From Prescott's Electricity & Electric Telegraph. [D. Appleton & Co.

The carbon plates are capped with lead to provide an attachment for the binding screws, as copper would be attacked by the ammonia; but a salt of lead is formed between the carbon and the metal which in time insulates them from each other. To prevent this the carbons are dried and heated to about 120° Centigrade; their tops are then dipped in melted paraffin and covered with lead, great care being taken to press the lead closely into contact with the carbon. It is not absolutely necessary to amalgamate the zinc, but the amalgamation tends to prevent the formation of crystals upon its surface. When the sal-ammoniac has nearly been removed from the liquid, it is unable to dissolve the zinc chloride, and in consequence becomes milky in appearance; more sal-ammoniac must then be added. When the battery begins to fail, the porous jars may be soaked in water, but this process cannot be adopted a second time. The cell should not be filled more than two thirds of its depth.

The Marie-Davy Battery:—Marié-Davy's quicksilver element is very successfully used in France at the present time. It is a zinc-carbon element, in which the zinc stands in pure water and the carbon in a paste of moistened proto-sulphate of mercury in a porous cup. The reduction in the inside of the element follows the same course as the Daniell; the zinc becomes oxidized through the oxygen of the decomposed water, and the hydrogen which is set free reduces the oxide of mercury which proceeds from the decomposition of the sulphate. The sulphuric acid gets over to the oxide of zinc and forms sulphate of zinc, while hydrogen goes to the oxide of mercury, uniting with its oxygen and forming water, and metallic mercury forms on the bottom of the porous cell. According to French authority 38 elements were in uninterrupted activity for six months without requiring any cleaning or renewing whatever, the current being equal to 60 Daniell elements, while the dimensions were smaller than the Daniell, which under the same conditions, only lasted three months.

The Sulphate of Lead Battery:—The Sulphate of Lead Battery is also the invention of Marié-Davy. It is constructed in the form of a column and occupies but little room. It consists of a series of tinned iron pans *a*, *a*, *a*, provided with three arms placed horizontally at equal distances apart. The bottom of each pan rests upon a zinc disc, and is coated inside with pulverized sulphate of lead moistened with water. The pans are piled one above the other, between three wooden posts, *D*,*D*,*D*, provided with iron screw heads, on which the pans rest by their three horizontal arms *c*, *c*, *c*. The wooden posts *D*, *D*, *D*, are placed on a wooden frame *E*, *F*.

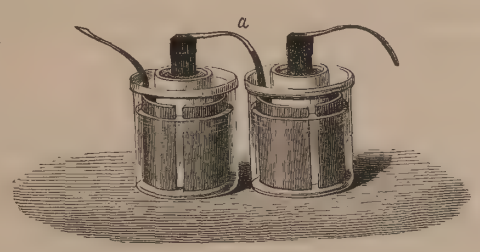


Fig. 19.

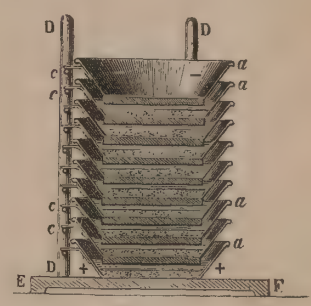


Fig. 20.

The battery is charged by pouring water into iron pans. The sulphate of lead is almost insoluble in water, but it is a good conductor of electricity. The zinc is attacked, the lead salt is reduced, and zinc sulphate and metallic lead are deposited on the bottom of each pan. The electro-motive force of this battery is inferior to that of Daniell, but in consequence of the great conductibility of the sulphate of lead, its resistance is much less, and the resistance still further decreases as the fluid becomes charged with sulphate of zinc. The battery is easily kept in order, it being only necessary to supply the water lost by evaporation. The current generated will be greater if a saturated solution of salt and water be used instead of common water.

Like the sulphate of mercury element the sulphate of lead battery loses its power very rapidly when worked upon a circuit of small resistance.

The Sand Battery:—The batteries originally used to work the English telegraphs, and the Bain telegraphs in this country, were composed of amalgamated zinc and copper plates $4\frac{1}{2}$ inches long by $3\frac{1}{2}$ inches wide, the zinc being $\frac{3}{16}$ of an inch thick. The plates were cemented, water tight, on to stout teak wood or oak troughs, each trough being from 15 to 30 inches long and $5\frac{1}{2}$ inches wide, and divided into 12 or 24 cells by partitions of slate. The plates, connected together by copper slips, were placed across the slate partitions, and the cells were filled to within an inch of the top with siliceous sand, which was then saturated with a mixture of one part sulphuric acid and fifteen parts of water.

The Graphite Battery:—This battery is used in England to some extent for ringing signal bells on the railways, and consists of platinized gas carbon and amalgamated zinc plates plunged in dilute sulphuric acid. The carbon plates are platinized by the electrotype process, using a straw colored solution of platinum, with a battery of 4 plates. The tops of the plates are electrotyped with copper, which is afterward tinned, and the connecting straps are riveted to the plates with tinned rivets, and then soldered. The electrotyping of the top of the plate is accomplished by placing the part to be covered with copper in a saturated solution of blue vitriol, and connecting it to the — pole of a single Daniell cell, the + pole of which is connected with a copper plate in the same solution with the carbon, but not touching it.

If the jar is considerably deeper than the plates, so that the solution of sulphate of zinc can fall to the bottom as it forms, leaving the lighter acid at the top, the battery will last for a long time. It is not, however, suitable for a continuous current.

ANOTHER "FIVE DOLLAR" IDEA---HARD RUBBER BEARINGS.

Hard rubber (vulcanite) on brass or any other metal will, when used under water, subject to friction, wear a dozen times longer than any two metals under the same usage, and hard rubber on hard rubber or glass is almost indestructible.

Pistons and cylinder bushings; valves and valve seats for pumps and water meters to be used in cold water, will, if made of this material far outlast any metallic one that can be made.

J. E. S.

CURIOUS COINCIDENCE OF THOUGHT AND EXPRESSION.

The Iron Age. in its issue of October 18, page 7, has an article on *Zinc*, which is an exact duplicate of an article of similar title in the REVIEW of September 15, page 123. The issue of *The Scientific American* of November 17, 1877, page 308, has an article on *The Manufacture of Jewelry*, which is a fac-simile, as far as it goes, of an article of the same title in the REVIEW of July 28, 1877, and which was bought and paid for by the publishers of this journal.—EDS.

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POWER-TRANSMITTING MECHANISM.

DRIVING POWER OF BELTS COMPARED WITH WORKING STRESS ON GEARING—I.

BY J. H. COOPER.

Next to the need of a reliable rule for ascertaining the quantity of belt necessary to do a given work, is the means of properly proportioning other working parts of a machine in which the belt is used. Of these, toothed wheels may be considered worthy of notice in this relation.

In nearly all power tools, and in many machines for special manufacturing purposes, both belting and gearing form essential elements of the *organa*, or acting mechanism, and it is just as needful to provide definite proportions of *diameter*, *pitch* and *face* in gears as to give proper pulley contact, breadth and velocity to the belt; in fine, each should be commensurate with the other, in a mechanical sense, and no machine is properly designed in which this equality of apportionment is not provided.

We have established as a safe rule to go by in "Use of Belting," for continuous working stress on each inch of width of single leather belting, the allowance of 55 lbs.; and this is based upon many experiments and upon the dicta of good authorities.

We do know by workshop trials that such a belt will safely carry a load of 100 lbs., and with good leather, lacings and joinings double that strain at rupture. Having appointed these figures for general service we can, with some certainty of arriving at comparative values, go for the carrying capacity of toothed gearing.

First is a presentation of the rules, old and new, for horse-power, from the most notable engineering treatises, reduced to a similar form and made up of the simple, necessary and practical elements; and next a tabular collection of formulæ for stress on the teeth of cast iron wheels, also reduced to a common form and coupled with worked-out examples from like elements.

The following tables exhibit the formulæ of several approved authorities for ascertaining the horse-power of and the stress on the teeth of wheels of cast iron:

Let p = pitch of teeth in inches.
t = thickness " " "
l = length " " "
f = face " " "
S = stress on teeth in lbs.
$t = .46$ p.

d = diameter of wheels in feet.
n = Rpm. = rev. per min.
v = Fps. = velocity of pitch line in feet per second.
H = horse-power transmitted.
$l = .7$ p.

Each formula is solved by the introduction of the following elements: the results are placed in the 4th column and show plainly the values of H and S according to each authority.

$p=3''$; $t=1{\cdot}38''$; $l=2{\cdot}1''$; $f=7{\cdot}5''$; $d=5'$; $n=60$; $v=15{\cdot}708'$.

	No.	AUTHORITY.	FORMULA.	HP.
From Bourne on "Steam Engine."	1	Boulton & Watt.	$H=\frac{p^3\times f\times d\times n}{306}$	66·17
	2	Carmichael, 1814, copied by Grier and Templeton.	$H=\frac{t^2\times f\times v}{2{\cdot}27l}$	47·06
	3	Stripe.	$H=\frac{t^2\times d\times n}{8\frac{1}{3}}$	68·56
	4	Tredgold.	$H=\frac{p^2\times v}{1{\cdot}75}$	80·78
	5	Farey, 1827.	$H=\frac{p^2\times f\times d\times n}{240}$	84·37
	6	Hick.	$H=\frac{p^2\times f\times v}{16}$	66·27
	7	Roberton, 1814.	$H=\frac{t^2\times f\times v}{4}$	56·09
	8	Glasgow Practical Mechanic.	$H=\frac{p^2\times v}{2{\cdot}5}$	56·55
	9	" "	$H=\sqrt{\frac{p^2\times n^2\times f}{4{\cdot}5}}$	73·49
	10	Buchanan, 1814.	$H=v\left(\frac{t}{{\cdot}75}\right)^2$	53·18
	11	Haswell, 1868.	$H=v\left(\frac{t}{{\cdot}465}\right)^2$	138·558
	12	Molesworth, 1875.	$H={\cdot}06p^2vf$	63·62
	13	D. K. Clarke, 1877.*	$H=\frac{p^3dn}{58.3}$	46.31
	14	Nystrom, 1854.	$H=\frac{t^2v}{0.4395}$	68.06
	15	" "	$H=\frac{p^2v}{2}$	70.686
	16	" 1875.	$H=\frac{tfv}{0.55}$	2 95.59
	17	" "	$H=\frac{pfv}{1.2}$	294.525

For gun metal (C & T)÷33.9; for wrought iron÷20.2; for steel÷13.1.

No.	AUTHORITY.	FORMULA.	RESULT IN LBS.
1	Tredgold, 1838.*a*	$S=138pf$	3,105.
2	Boulton and Watt	$S=\left(\frac{p}{{\cdot}0517}\right)^2$	3,364.
3	Morin	" "	3,364.
4	Tredgold copied by Rankine in 1873.	$S=1500t^2$	2,896.6
5	Rankine, 1873	$S=160pf$	3,600.
6	Eng. and Mach. Assist.	$S=1600t^2$	3,047.
7	" " " *	$S=\left(\frac{t}{{\cdot}025}\right)^2$	3,047.
8	J. G. Lawrie.†	$S=510pf$	11,475.
9	Haswell, 1860.	$S=135pf$	3,037.5
10	" 1868.	$S=\frac{720\times f\times t^2}{l}$	4,886.
11	Nystrom, 1854.	$S=1600t^2$	3,047.
12	" "	$S=300ft$	3,105.
13	" 1875.‡	$S=1000ft$	10,350.
14	" "§	$S=460pf$	10,350.
15	W. C. Unwin, 1877.¶	$S=200pf$	4,500.
16	F. Campin.	$S=\frac{1333\frac{1}{3}ft^2}{l}$	9,068.6
17	D. K. Clarke, 1877.††	$S=180p^2$	1,620.
18	J. Christie, 1877.**	$S=462pf$	10,390.

a Giving results near those of his table in his treatise on the steam engine. London, John Weale, 1838.
*S= stress at pitch line, can be loaded to half more and yet be within the elastic limit.
†Use .035 for brass and .038 for wood.
‡This rule provides for carrying the load always on two teeth, and is thus equivalent to $\frac{1}{16}$ the breaking strain.
¶$\frac{7}{10}$ of the stress, by this rule, should be put on wooden teeth. This formula deduced from table on page 184 in his "Elements of Machine Design."
††Equal to $\frac{1}{10}$ the breaking strain; for cast irons, 180 to 310; for gun metal (C. & T.), 310; for wrought iron 520; for steel, 800.
**This rule $=\frac{1}{8}$ breaking strain; $\frac{1}{6}$ may be taken for ordinary hard worked gear, and $\frac{1}{4}$ for well supported, quiet working gear. See article following.

Having now presented rules, in some variety, for ascertaining the strength of the teeth of wheels from first-class sources, it becomes our duty to clear up a difficulty which forces itself upon the mechanic who takes the responsibility of the work he executes, and that difficulty is to gain full confidence in the reliability of the rule he is using—he must have taken solid steps to the foundation upon which the elements of the rule depends, and know to a surety the material of which the structure is built.

Upon these essential features of the case, the criteria of almost every engineer's guide book is silent. To stand safely, therefore, on the certainties of knowledge, one must have definite and accurate means of assertaining the mechanical properties of the materials upon which he is going to depend, and in the line of this branch of the inquiry we present the data from which Boulton and Watt made their rule for the strength of the teeth of wheels.

"A bar of cast iron one inch square and twelve inches long bears 600 lbs. before it breaks; one inch long will bear 7,200 lbs., and $\frac{1}{15}$ of this = 480 lbs., which is the load that should be put on a wheel."

Prior to this test we have the record of John Banks, in 1803, on 1"□ cast iron 3' between supports giving, in 10 experiments, an average of 844 lbs., ranging from 730 to 972 lbs. at the middle of the bar, producing rupture.

To find the pressure that breaks 1"□ section at 1" distance from the support we have $\frac{844\times 36}{4}=7596$ lbs.

Rondelet's 6 trials in Paris in 1814 averaged 6,012 lbs., and later, Tredgold's five trials averaged 7,416 lbs. on cast iron bars of same section and length.

In Pole's work on "Iron," 1872, page 90, occurs the following: "There is an exceedingly simple rough datum for the transverse strength of cast iron which is well worth committing to memory. It is, *that a bar* 1 *inch square and* 1 *foot long will break with a load of about* 1 *ton* hung on the middle."

In this we have $\frac{2240\times 12}{4}=6720$ lbs. on 1"□ by 1" long.

Barlow says: "Cast iron has its elasticity destroyed with about one-third the weight that will produce rupture; it ought not therefore to be loaded in permanent constructions to more than this amount."

Mr. F. Campin, C. E. in the *Artizan*, says: "It is found that a cantilever of cast iron 1" long, 1" wide and 1" thick breaks under an extreme load of 8000 lbs. To find the qreaking weight of any given cast iron cantilever loaded at the end, multiply the breadth in inches by the square of the thickness in inches, the product by 8000, and divide by the length in inches. In practice, it is usual to make the working stress $\frac{1}{6}$ of the breaking weight, then the formula for safe load would be: $S=\frac{8000ft^2}{6l}$ or to put it in the same form as the others, see rule 16 in the table above.

We can therefore rely upon Boulton and Watt's data, *i. e.*, 7200 lbs. breaks a bar of cast iron 1"□ by 1" long; $\frac{7200}{3}=2400$ lbs. the elastic limit, which, if exceeded, would end in rupture, and $\frac{2400}{5}=480=$ the safe load.

The question of how many pounds pressure upon the point of the tooth, whose elements are given above, will be necessary to break it, may now be considered.

For this we have $\frac{7200\times 7{\cdot}5\times 1{\cdot}38^2}{2.1}=48{,}970.$

and $\frac{1}{15}$ of this is 3,265 lbs., which is near to an average of the rules we have tabulated in this article.

The truth of the whole matter, therefore, becomes clearer to us in the light thus shed upon these formulæ, which were put into shape in times and distances so far asunder that one cannot well help believing the authors of them employed similar material and pursued the same line of inquiry in their prepraration.

TAWING.

The preservation of animal skins by the means of alum, salt, or other materials is called tawing According to the country and the leather, this preparation greatly varies.

1st. Tawing with alum and common salt.

2d. Hungarian tawing (the tallowing being one of the most important operations).

3d. Erlanger, or French tawing.

4th Knapp's tawing by the aid of insoluble soaps.

The theory of the action of the alum in the above operation is not as yet well understood, at one time it was believed that only the chloride of aluminium was the chemical that combined with the skin, and that their remained in solution hydrochlorate of alumina.

Experiments made by Knapp have proven that no decomposition takes place when the aluminium is absorbed by the skin. These experiments are very interesting, but are far too scientific for the general reader. Consequently I will now speak of a subject that we all are likely to take great interest in, *glove leather*, that is, its history and preparation:

Manufacture of Glove-Leather and its Uses.

The Erlanger method is only employed for the production of kid-leather.

Great care is necessary in this manufacture to avoid stains or spots of any description, as the color remains frequently white or is dyed in very delicate tints.

Two kind of skins can be made use of, young goats and lambs' skins, the first being the most expensive.

The skins are well soaked in running water, they are then worked on the flesh side, which is afterward rubbed with a cold milk of lime and placed one on the other (flesh against flesh), the hair then gives easily.

They are then placed in running water to get rid of the excess of lime, and the hair is plucked out with spring tweezers, they are then placed for steeping in a weak solution of lime and water, this operation lasts about three days, after which they are placed in a fermenting mixture of bran and water.

They are now ready for tawing (so-called), which has not only the effect of preservation, but renders them soft and supple.

The mixture consists of part compound of wheaten flour, yolk* of eggs, alum, common salt and water. (In England and France 60,000,000 of eggs are yearly utilized for this purpose alone). The gluten contained in the flour helps the absorption of the alumina compound—consequently assists the real tawing.

The skins are now white, and are to be dried, which is done by placing them in a loft for one week, (having been previously stretched by hand.)

They are then damped and placed between linen cloths and beaten to render them soft (sometimes a softening iron is made use of to "reduce all unevenness and to develop whiteness.)

Then again pumice stone is made use of to polish, but this operation varies greatly, according to the country, in Italy and Spain the idea of producing a gloss, &c., differs somewhat from the above; and within the last few years white of egg, or a solution of gum or soap is placed on the surface, and is rubbed with a polished glass disc.

The method of coloring also greatly varies, in France it requires three or four operations, and in Grenoble the color is given after one dyeing by immersion. The other by brushing the leather with the color desired and then permitting to dry, thus causing a series of handling, giving danger of soiling the skins, but when done with care the result is very uniform and satisfactory.

The French from an early period down to the present day excel in the manufacture of glove-leather. In 1851, at the exhibition in London, a Philadelphia firm received a gold "medal" for samples sent over.

Gloves: Manufacture and History.

Gloves were not worn by every man, woman or child, in olden times like they are at the present day. Kings and great men were the only ones privileged of covering their hands by means of gloves, ornamented with rings of gold; deprivation of a glove on certain occasions was considered a degradation.

Those that are familiar with the writings of Hormer remember that he speaks of Loetres wearing gloves to protect his hands whilst working in the garden.

The idea of giving a glove as a contract is very ancient, and the act of throwing one as a challenge is supposed to be derived from this. In some parts of Europe it was the custom to take off one's gloves when entering the stable of a great man.

Presenting a pair of gloves for any favor rendered is a very old habit, and originated about 1245, and is practiced up to the present day. Embroidered gloves were not made until 1580, a few years later Louis XIV prohibited these or any others to be worn, this was very like many other things this king did which were more eccentric than any thing else.

Gloves were and are still made of various materials, according to the country in which they are to be worn; in Russia and in the northern parts of the world they are most generally lined with fur; but in other countries the kid is the article that takes the place of all others. Queen Elizabeth had great fondness for perfumed gloves, and one pair in particular may be mentioned, those presented to her by Edward Earl, of Oxford, when he returned from Italy.

The finest kid gloves are made in France, the cheaper come from England; they make use of dog, rat, &c., skins. Generally one goat skin will yield two pair of gloves.

Great skill is required for the cutting of the skins to the best advantage, this was done at one time with a pair of scissors, after having rubbed the skins, with a blunt knife on a marble slab.

The pieces for the thumb, the gussets for the fingers and the pieces to go between, must all be worked out from the same skin or others similar.

Making a hole for the thumb requires the greatest skill, as the slightest deviation from the exact shape will cause a bad fit. The workman had nothing to guide his eye in these various operations and very little allowance was made for stretching. The consequence of this was, that but few gloves were shaped alike.

In 1819, Viollet Artons invented a punch by the means of which several dozen could be cut at the same time.

In 1834, Jouvin, a young and intelligent mechanic, having a good education and understanding the principles of geometry made an invention which was a great improvement to the above, as it was not confined to one size, but to every dimension that might be desired. He made a calculation, and found that thirty-two sizes would include hands of every description; he classified each of these under five headings: very slender, slender, medium, broad and very broad. These were again divided in two, thus giving three hundred and twenty in all, very few of which are ever called for. These patterns were frequently provided with a toothed apparatus somewhat resembling a comb, which makes the points for the stitches.

The seams are sewed with perfect regularity by placing the edges to be united between the jaws of a vise, on which are fine brass teeth, through these the needle is made to pass.

The glove sewers generally commence by placing the thumb, then sewing the long seam from the wrist to the end of the little finger.

The accompanying cut †represents the number and shape of pieces required to make a kid glove. Upward of 3000 stitches are necessary to put the pieces together and finish the glove.

When finished they are placed for the second time between damp cloths where they are beaten and rendered more soft and flexible.

The glovers in France celebrate a day in honor to St. Ann, mother of the Virgin, having according to the monks been accustomed to knit gloves.

Excellent gloves are made in Italy, and especially at Naples; in Belgium, Sweden and Denmark, about 2,000,000 dozen pairs of gloves are yearly manufactured, two-thirds of these are made in France. England exported 689,604 pairs of kid gloves in 1860, and imported 10,619,220. 500,000 cotton gloves are sent from there to this country. The value of gloves imported last year amounted to 3,000,000 dollars.

The chief branch carried on in this country is the manufacture of buckskin gloves. It is to be hoped that in time we will no longer trouble the French for an article that now is in a great demand, but will on the contrary send kid-gloves to them, as we are now doing with our cotton goods since the war of the rebellion.

L. S. Ware, C. E.

*Some manufacturers think that many advantages are derived by substituting olive or fish oil for yolk of eggs.

†The trade-mark of Mr. M. D. White, of Philadelphia, to whom we are indebted for the use of the plate.

THE BAND SAW.

Saws may be divided into four general classes—reciprocating, circular, cylindrical and band or ribbon. The office of a saw is to sever by removing or wasting material; hence the thinner a saw can be had the more economical of power and materials. There is a certain limit of thinness beyond which a mulay saw cannot go without bending, &c., as long as it has a thrust instead of a pulling cut. The sash (or gang) saw can be made thinner than a thrust-cut mulay, on account of being strained from both ends. The circular saw commences to limber out and wave at too high velocities, and (except for veneer cutting) must be thinner at the centre than at the circumference, to give clearance and prevent binding and heating. Some economy of kerf and power is gained by the "double circular" mill, when two small circulars running in opposite directions, one cutting from the top and the other from the bottom of the log, in the same plane, are used instead of one large one. Something partly answering the purpose of straining is gained by the "side-guides" of the circular saw; but still they waste stuff and power. As the cylinder saw never comes into competition with the Mulay, sash, circular or band saw, it may be left out of the present consideration.

The band saw has the advantage which the sash saw has over the Mulay, in being strained; and that which the circular has over both the Mulay and frame saw in having a continuous instead of a reversing motion. The latter property makes it steady, running like the circular, and the former permits of its being thinner than the circular, and making, in consequence, less kerf and taking less power to run it. It has the additional advantage over the circular that it will cut other than in straight lines or flat planes.

The circular should not be used for work thicker than one-third the saw diameter. A 20″ square cant hence necessitates a 60″ circular, with a thickness of $\frac{1}{4}$ inch, and a kerf of $\frac{5}{16}$; or two 30-inch saws, $\frac{3}{16}$″ thick cutting out a $\frac{1}{4}$″ kerf. If we are cutting inch stuff with the single saw we need nearly $\frac{21}{16}$ inches of wood to make a $\frac{1}{16}$ board; which looks very much like $\frac{5}{16}=31\frac{1}{4}$ per cent. kerf, compared with the board, or $\frac{5}{21}=23.8$ per cent. of the entire square cant wasted.

Using the double mill and thinner saws, we find about $\frac{5}{4}$″ of wood necessary to the production of a $\frac{4}{4}$″ board; being 25 feet of kerf for every 100 feet of board; or 20 per cent. of the log turned into sawdust.

A band saw to effect this same work, need be but $\frac{1}{16}$″ thick and cut a kerf of but $\frac{3}{32}$″. This means that an inch ($\frac{32}{32}$″) board takes but $\frac{35}{32}$″ of wood to cut it; being $\frac{3}{32}$ as much kerf as board; and $\frac{3}{35}$″ or $8\frac{1}{2}$ per cent. of the log wasted in sawdust. In other words the band saw cuts $\frac{3}{32}$″ kerf to the single circular's $\frac{10}{32}$″, which looks as though it made $\frac{10}{3}$, or $333\frac{1}{3}$ per cent. as much in kerf as the band (and consequently in power). A 20″ cant which is $\frac{320}{16}$″ thick, will cut about $\frac{320}{21}=15$ one-inch boards if a circular be used; but if a band saw be used it would cut about $\frac{640}{35}$ or 18 one-inch boards. The band saw is hence $\frac{3}{15}=20$ per cent. more economical as regards products. If the same saws were set to cutting half-inch stuff out of a 20″ squared log, the circular would take $\frac{8}{16}+\frac{5}{15}=\frac{13}{16}=\frac{26}{32}$ of wood to cut a half-inch board, and the band would take $\frac{16}{32}+\frac{3}{32}=\frac{19}{32}$ of stuff to cut out the same. The circular would hence take $\frac{26}{19}$ as much stuff for a given product as the band; its excess of stuff required being $\frac{5}{19}$ or 26.3 per cent. A 20″ square cant would cut $\frac{320}{13}$ or about 24 half-inch boards with the circular, while with the band it would cut about $\frac{640}{19}=33$. Producing half inch stuff the band would turn out $\frac{33}{24}=129$ per cent as much stuff as the circular.

It will be seen that in re-sawing the band presents especial advantages in economy of stuff and power. As regards quality the band should scratch less stuff than the circular. The band offers for ship-timber cutting the best advantages of the circular in smooth and continuous action, and that of the scroll (or "jig") in capacity to saw at any angle, curve or bevel.

G.

ON THE TEETH OF GEAR-WHEELS.—III.

SIDE-NOTES FROM THE SCHOOL OF MECHANICAL ENGINEERING OF THE ILLINOIS INDUSTRIAL UNIVERSITY.

The two previous articles were confined chiefly to epicycloridal tooth-gearing, with radial flanked teeth. In the present one let us consider the case of curved flanks, the teeth being still of the epicycloidal form.

We have seen that the epicycloid is described by rolling a circle, which carries a tracing point in its circumference, upon the outside of another fixed circle. By making the fixed circle hollow, or a ring, and rolling the movable circle inside of it, the curve presented is called the hypocycloid. Such is the curve. *EF*, Fig. 6, obtained by rolling the circle *D* inside of *B*, carrying the tracing point *P*.

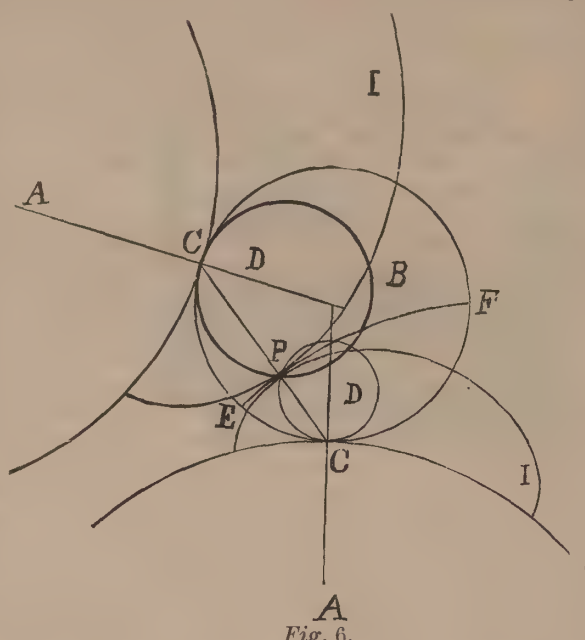


Fig. 6.

When the diameter of *D* is less than the radius of *B*, the hypocycloid *EF* is concave towards *D*, and convex towards it when greater. When the sum of the diameters of two circles *D* equals the diameter of *B*, both will describe identically the same hypocycloid. The figure is made double, partly with a view to show this. The two points *C* being instantaneous axes for *D*, the chords *CP* may be regarded as radii of extremely short portions circle arcs at *P*, which, thus short, will appreciably coincide. This is not only true of the several circles in the positions figured, but must hold for all similarly related positions. This results in a description of a common hypocycloid *EF*, by each circle *D*.*

When the two circles *D* become equal, *EF* become a diameter of *B*. This is the case in Fig. 1, of a previous article, on radial flanks: so that radial flanks are real hypocycloids. This suggests that *EF*, Fig. 6, may serve as a curved flank for teeth of a pitch line *B*.

Indeed, this is seen to be a fact by regarding *A* as the counter-pitch line of a pair of wheels. *D* rolling on *A* gives an epicycloid *PI*, which is related to *EF*, as regards contact at *P*, just as the epicycloid was to the radius in Fig. 1. Hence, a portion of *PI*, taken as a face of a tooth of *A*, works correctly on a flank taken from *EF*. It is to be remembered that *D* should roll in the same direction, outside of one and inside the other pitch line, to describe a face and flank couplet. Also, by interchanging *B* and *A*, other things remaining the same, we may describe those parts of the teeth which are on opposite sides of the pitch lines. Hence, the general principle for epicycloidal teeth with curved flanks, viz:

To produce a face and flank which will work in mutual accord, roll a tracing circle upon the outside of one and inside of the other pitch lines in the same direction.

It is evident that where faces and flanks are not to work interchangeably in a pair of wheels, different circles *D* may be employed for different couplets. For instance, in a pair of wheels made 2 to 1, all the teeth of the smaller may differ from each other as regards size and form. The larger wheel of course would consist of two equal halves. A model illustrating this to such an extreme that the wheels could scarcely be recognized as having circular pitch lines, was exhibited at the Centennial in the cabinet of the school named at the head of this article. In this model, however, the teeth were not all epicycloidal, showing the greatest possible generality, for circular pitch, lines of the principle just set forth.

As we are at entire liberty of assuming the circle *D*, Fig. 6, it appears that if one size results in any advantage over another, we may accept it at once. We will therefore consider, in the following, some of the many special cases pointing out the peculiar merits of each. We will consider the teeth as all made alike in a given pair of gears. Let us first notice

STRONGEST EPICYCLOIDAL TEETH.

As to the strength of teeth, they are usually regarded as beams fixed in a wall at one end and loaded at the free end. Such a beam will break close to the wall, unless it is thicker there than at other points nearer the end. But teeth with radial flanks are narrower, nad hence weaker at the base than even parallel flanks. It is evident, then, that the teeth should be thickened at the base, so as to converge towards the points, in order to make the best showing for strength. Though teeth are usually formed with thickened flanks in practice, still no special rule has ever been adopted for proportioning this thickness.

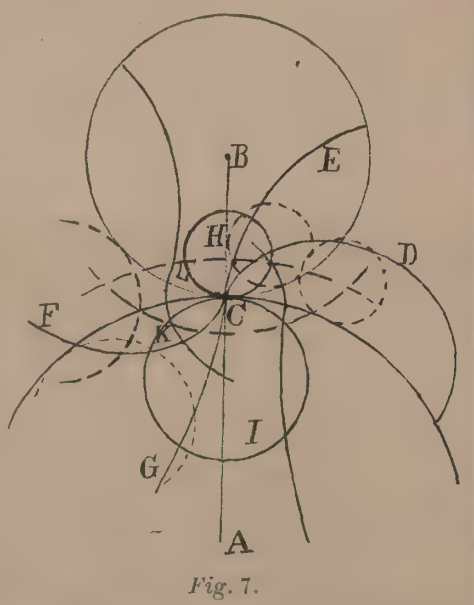


Fig. 7.

The best rule is simply to assume the rolling circle of such size in each case as will give a desirable form of tooth. When the wheel has few teeth, say 10 or 15, the rolling circle may require to be somewhat different than when the same pitch line has many teeth. For securing strength, it should always be small enough to show an appreciable departure of hypocycloid from a radius within the limits of a flank length.

To better illustrate the case in hand, let Fig. 7 represent an instance of pitch lines about 2 to 1, with the flanks nearly parallel. These are stronger than radial flanked teeth. The rolling circle *H*, tracing point at *C*, will describe *CD* in rolling *on A*, and *CE* in rolling *in B*, and *I* will describe *CF* in rolling *on B*, and *CG* in rolling *in A*. The diameters of the rolling circles are seen to be considerably smaller than the radii of the pitch circles to give reasonably flaring flanks. Another noticeable feature is the inclining of the faces toward each other as the flanks are turned outward, and hence a greater general inclination of the side of a tooth than in radial flanks. This causes a correspondingly increased crowding of the teeth and wheels from each other, and against the axles. This entails increased friction of axles, and a consequent greater working pressure upon the teeth of the driven wheel. This latter effect is slight for a single pair of wheels, but in a train of gearing it increases in a geometrical ratio, and may fully counteract in increased resistance, the gain in strength of curved over radial flanks. If in radial flanks it were not possible to strengthen the teeth by clearing curves, there would be greater advantage in theoretically curved flanks; but with such curves introduced, the possible bases of the teeth are seen to be but a trifle more slender in the former than in the latter. The so-called radial flanked teeth may therefore serve an excellent purpose in practice; at least it appears decidedly preferable to use clearing curves for strengthening teeth than flanks curved by theory, unprovided with such curves.

There is one point, however, in favor of curved flanked teeth which should be noticed, viz: the portion of flank upon which the face acts is greater than if the flank is radial. The intersections at *L* and *K*, Fig. 7, of the rolling circles with addendum circles,† indicate the last possible centact of any face and flank. This is evident from the fact that the point of contact, in epicycloidal gearing, is always on the rolling circles *CL* and *CK* when tangent at *C*, and hence cannot be more remote from *C* than where the addendum circles of the teeth meet *H* and *I*. Now it is plain from a simple inspection of the figure, that the points *L* and *K* are farther from the pitch circles as *H* and *I* are smaller, and hence the greater extent of flank contact.

It may not be unprofitable to reflect upon the effect of contracting this flank bearing. The faces of the teeth, from the nature of the case, will sweep their whole lengths upon whatever flank bearing there may be available; and, as a general thing, the latter will not be more than from a fourth to a half of the former, according to form of tooth curves. Admitting that the wear of surfaces under equal pressure is proportional to the extent of those surfaces, it follows that the flanks will be most rapidly cut away. Abundant evidence in support of this is found in old gears much worn, the teeth of which are often badly undercut.

The shapes assumed by the wearing of the teeth are also very likely to be erroneous, so that the velocity ratio, of the gears undergoes fluctuations, are repeated for each tooth passage. Good judgment on the part of the designer is, therefore, a valuable ingredient in the make-up of gears. For instance, a pair of gears not in a train, working where they are subject to a gritty dust, would advisedly be given quite strongly curved flanks, carrying *L* and *K* quite far away from the pitch lines; whereas, in *trains* well protected, radial flanks would be better.

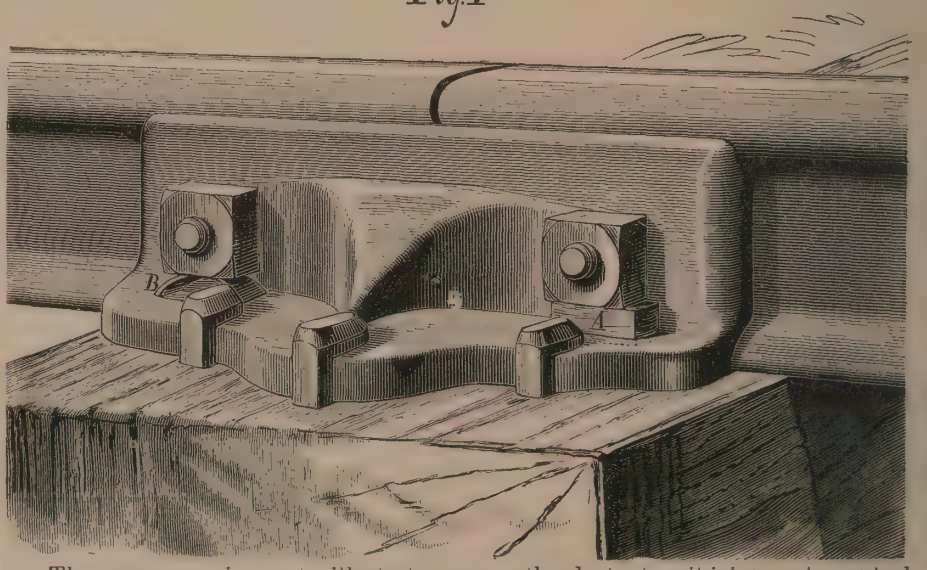
S. W. ROBINSON.

†The circle which limits the points of the teeth is called the addendum circle.

*We might add, as an interesting fact, that every epicycloid has this peculiarity of double generation. See *Van Nostrand's Scientific Series*, No. 24, page 25.

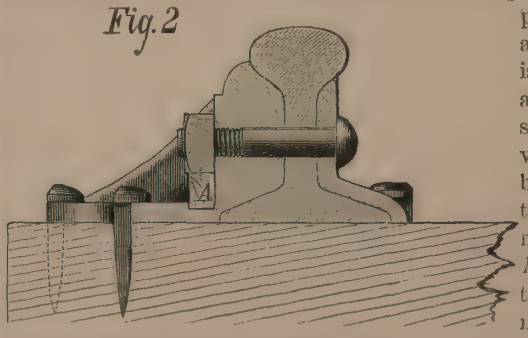
NICHOLLS' RAIL-JOINT AND NUT-LOCK.*

Fig. 1



The accompanying cuts illustrate a recently devised rail-joint and nut-lock, especially intended for use on pear-head rails, a form too low for fish-plates and bolts; but on account of the lesser strain on the holding-spikes, due to the diminished leverage produced by its small height preferable to the ordinary T rail. The joint is molded and matched to the rail, and, unlike the fish-plate, requires no spike in the flange of the rail to prevent creeping. The nuts are locked by driving wooden or iron keys under them, as at *A* in the figures, the same fitting into a groove cut in the brace. *B* is a steel spring which may be made to answer the same purpose. The mass of metal between the two nuts is well placed, for it is there that all the lateral strain is brought on the joint.

Fig. 2



*Mr. T. J. Nicholl, Chief Engineer of the G. C. and S. R. R., Springfield, Ill., is the inventor.

MANUFACTURE OF EARTHENWARE.

The manufacture of earthenware is conducted in a manner analagous to the porcelain. As examples of this kind of goods, may be mentioned majolica ware, the faience of the French, the delft ware of the Dutch, and common varieties of pottery which are in use in England and this country.

It was Josiah Wedgewood who brought to perfection the manufacture of earthenware. He introduced new glazes, new material, and new methods generally, and founded a vast industry in England.

The clay for this manufacture is generally weathered for one or two years before being used; it is thus given a better color and rendered more pliable. After this exposure, certain quantities are weighed out, put in large vats and worked together until they are thoroughly mixed and become of the consistency of thick milk. Other ingredients are then mixed with these clays, such as feldspar, kaolin, and a few others to give body and consistency to the ware. After the whole has been ground and mixed up together, it is put in a large press, and, by means of heat, the materials become more solid and better for use.

An earthenware manufactory is arranged in such a manner that each branch is kept separate. In making a water pitcher, the body of the pitcher is made in two equal parts, and the handle is made separately. The presser, as he is called, takes sufficient clay for the molds, and when both halves are filled he puts them together and straps them tightly; he then finishes the inside of the pitcher by smoothing with a wet sponge. He then takes off the strap and places the mold, with its contents, in a small room which is kept at a high temperature. This is done to harden the clay and evaporate the water. After awhile the clay appears white, and the mold is taken out and opened. The pitcher is then finished off, and the handle put on. This being done it is ready for its first baking.

Within the last few years earthenware manufactories have increased rapidly in this country. There are now extensive establishments at Trenton, N. J., East Liverpool and Cincinnati, Ohio, Geddes, N. Y., and St. Louis, Mo. The industry bids fair to become a flourishing one in the United States.

There is another branch of this business which, a few years ago, was in an experimental condition in this country—namely the manufacture of fire-bricks. For a long time nearly all the fire-bricks used here were imported from England; at the present time the production in America has reached more than $50,000,000 annually, with a prospect of a rapid increase.

In the decoration of porcelain called pate-sur-pate, or clay upon clay, the article ornamented is produced by the application with the brush of white liquid porcelain, used as a pigment, in successive layers upon the colored body of the ware; *i. e.*, a given thickness is added to it with a brush or by immersion, presenting a rough surface in relief, which is trimmed to the required design by cutting implements and sharp scrapers. By successive applications the painter, who requires also to be a modeler in the treatment of his subject, gains his effect of relief. When the bas-relief is completed, the object is subjected to several bakings or firings, and at the last firing it is covered with a coating of glaze. The strong oven fire vitrifies the porcelain and the pigment, embodying them together, and rendering the salient objects translucent. These portions, in vitrifying, retain a relief which forms the actual outline and the high lights, while its thinner parts enable the colored groundwork to be seen through. These form the transparency of floating draperies, clouds or flesh, according to design.

Pate-change-ante is so named from the color changing from grayish by daylight to a decided pink by candle-light. Messrs. Minton have succeeded in producing a similar dove color, which changes to a light crimson by artificial light. Graffito ware, meaning scratched ware, is of Italian origin, and is supposed to have been first invented in the province of Perugia, in the fifteenth century. It recalls the decorations upon the walls of the houses in Pompeii. The ware is made of two clays of different color. The body of the vessel is formed of a darker clay, and, after drying sufficiently to handle, it is dipped into a liquid slip, formed of the lighter-colored clay. As soon as the coating is dry the artist, with a sharp wooden or steel point, traces his ornament on the surface, removing the upper light-colored surface, and showing everywhere on the lines of the design the dark body beneath. The vessel is then covered with glaze and fired.

Henri Deux ware is the only description of pottery in which clays of different colors are inlaid together. The artist having made his design, each distinct part of the ornament is stamped on separate bats of clay. The design thus indented is filled up with another colored clay, and when dry the superfluous clay is removed.

Cloisonné enamel is a specialty in China and Japan. A vessel of copper is first made, and the lines of the pattern are traced on its surface. A fine wire, beaten into a flat supple riband, is then taken and soldered by one edge to the lines traced on the surface of the copper vessel. The wire stands on its edge, forming a number of cells or cloisons, which are filled with a paste, composed mainly of oxide of lead and silica, with some lime and soda, and colored as required, either with the oxide of copper, iron, or cobalt. The vessel is then fired at a heat sufficient to vitrify the paste, and finally the whole surface is polished by friction.

The character of the Chinese cloisonné work is coarser and bolder than that of the Japanese, and in both, the contrasts of color are successfully harmonized. This kind of ware has been very successfully imitated in Paris, and also by Minton, in England. Old Persian ware is distinguished by a special brilliancy and effectiveness of colors. good modern imitations have been made by adapting Persian patterns on turquoise and plum-colored enamel ground.

Belleek ware, from Ireland, is quite new. It is distinguished by the high, lustrous, silvery quality of the glaze, which attracts the eye, and recalls the peculiar coating of a sea shell. It is a genuine porcelain, according to the original derivation of the word.

Chinese and Japanese porcelain has been very thoroughly examined by chemists and potters, and the method of its manufacture has been fully described. The body of it is felspathic and hard; the glaze is softer than that of European hard porcelain, the colors are properly enamels, transparent or opaque; few coloring oxides are employed, and the whole is made in one firing, at a somewhat low heat.

Parian ware, like stone-ware and terra-cotta, is composed of clay, mixed with vitrifying ingredients, but it differs from these, both in aspect and composition, in being composed of purely granitic materials. In composition, it lies between stone-ware and English or soft porcelain.

Parian figures are produced from a mixed clay, poured in a fluid condition into plaster molds. Great skill is required to prevent the cracking of the material in firing.

If plaster-of-Paris, in fine powder, is thrown in a vessel containing a saturated solution of borax, after soaking for some time with a solution of alum, a hard plaster is obtained, which is called parian, although differing, in composition, from the above.

Earthenware is composed of plastic fire-clay, with an addition of fine ground quartz, or refractory stone, and occasionally lime. The ware is brought to a state of biscuit by one firing, and is able to withstand certain alterations of temperature. As the glaze of this ware contains lead, it is deleterious for cooking. Sanitary ware, free from lead, has been made, but the additional cost of the materials is considerable.

Decorative tiles for floors and architectural purposes are classified as follows; 1, plain tiles; 2, encaustic; 3, enameled; 4, majolica; 5, earthenware tiles.

Plain tiles are made from colored dust clay, by a sort of coining process, and are capable of being highly decorative when well made. The clay, or mixture of clays used, is usually reduced to a fine powder and made slightly damp before pressing.—Encaustic tiles consist of a slab of clay of uniform color, inlaid with a device of other clays, differently colored. In this ware the colors are not superficial, but are incorporated with the body of the clay before burning, either by pugging dry or in the condition of a liquid slip. Small holes are made in the back of tile to facilitate drying and to increase the adhesion of the mortar when subsequently used on the wall. The tiles are dried for a week, then heated in a drying oven for two or three weeks, fired in a stone-ware oven for sixty hours, and left in the oven for six days more to cool down. Enameled tiles are the same as plain tiles in their general composition. By reserving spaces (by oiling or otherwise), and dipping the tile in a slip, or by direct application of the enamels, simple and effective results are obtained. Majolica ware and majolica tiles date back to the earliest history of art.

In the year 1115, an expedition fitted out from Pisa, conquered the island of Majorica, and brought back, as spoils, the bricks and tiles which the Moors had manufactured there for a long time previous. This ware is known as majolica, and is highly prized. The Italians soon learned how to imitate it, and, by degrees, the art traveled northward into Germany, France, and England.

In England, the tiles are burnt, then covered with an opaque white glaze, upon which the outlines of the decorations are distinctly traced, and filled in with a thin coat of enamel, of various colors, and again burnt.

Terra-cotta, in its application to architecture, still has its advocates and opponents. Very fine specimens made in London, one hundred years ago, and exposed to the weather since, are still perfect. Terra-cotta, or literally "burnt clay," in order to yield a material as strong and more durable, and less expensive than stone, must be carefully prepared. In the north of England, the purest lumps of fire-clay are selected according to color and texture, and used alone without any other clay, while the firms near London prepare more carefully a mixture of clays, which produces a body of better texture. There seems to be, in every case, an advantage in using a mixture of clays, as a more compact, homogenous and better vitrified body is attained, although at the cost of extra labor and care.

In the fifteenth and sixteenth centuries, stone-ware, characterized by its dense, opaque, vitreous fracture, and impermeable and refractory nature, was already abundantly manufactured in Germany and Holland, whence the industry was imported into England, and encouraged by Queen Elizabeth. The materials made use of in England are the refractory white and grayish plastic pipe clays, of Devon and Dorsetshire, which are used alone, or mixed, for small articles. For larger objects, white river sand, ground fire-bricks and flint are added to counteract shrinkage and warping. The heat required is greater than for terra-cotta, being one of the highest necessary for any kind of pottery. The manufacture of terra-cotta and stone-ware are advantageously carried on together, as the refuse materials from the one can be used in the other, and the less hot story of stone-ware kilns, used for terra-cotta.

Bricks are made of somewhat meagre clays, containing a certain amount of oxide of iron and lime. Although fatter clays are easily molded, they shrink more, and even crack in the fire. The fluxes, iron, lime, etc., are useful, as they produce a solid brick at a lower temperature. It is scarcely necessary to go any further into the subject of brick-making, as the manufacture is familiar to everybody, and possesses little intrinsic interest.

The Assyrians kept their public records of conveyances of land, deeds, etc., on cylinders and tablets of clay, which were afterwards baked. These are handed down to us as material for deciphering the history of those times. A selection from these inscriptions has been published by the trustees of the British Museum. Inscribed earthen bowls from Babylon, assist in clearing up many obscure points in the early history of the Jews. "To this day," says Layard, "there are men who have no other trade than that of gathering bricks from this vast heap (the ruins of Babylon), and taking them for sale to the neighboring towns and villages, and even to Bagdad. There is scarcely a house in Hillah that is not almost entirely built of them."

Many bricks found in this region are coated with a thick enamel or glaze. Their colors have resisted the effects of time, and preserve their original brightness. The dwellings of the Chaldeans were ornamented externally, by diagonal patterns of colored bricks, sometimes molded into half columns, with a variety of wavy patterns. Internally, the plaster walls were embellished with colored cones of terra-cotta, imbedded in the plaster, so as to show either their bases or their points, or a part of their sides, combined in lines.

From the Assyrian and Egyptian days, we can pass to the time of the Greeks and Romans, and still we find an extensive variety of beautiful workmanship. The Etruscan vases are famous all the world over. On the Continent of North America there are mounds containing crude specimens of pottery, and in Peru and other States of South America, the decorations on tiles and vases are often of an elaborate and tasteful character.

It is a beautiful art, and everybody must rejoice to think that it is constantly increasing in importance and finish in this country. The time does not appear to be far distant when all styles of porcelain and earthenware will be skillfully manufactured in the United States. All the materials required have been found in abundance, and there would appear to be no good reason why the introduction of the business in all its branches should not be crowned with success.—*Prof. Charles A. Joy—Crockery & Glass Journal.*

"LEATHER."

This expression was made use of in the last portion of the first article on the Manufacture of Leather. The idea was to call attention to the fact that leather utilized for manufacturing purposes is obliged to go through many other operations before it is fit for general use. The greater portion of the community imagine that when skins have been placed in pits containing bark, the nature of which they are ignorant, and after remaining for a time unknown, they are taken out and dryed, leather is obtained, which is sold immediately to the shoemaker, saddler and glove manufacturer.

Those familiar in any degree with the art of manufacturing leather, know that such is not the case, but subjected to an operation called *currying*, before they can in any way be utilized. In order to show that skins can be tanned not only with bark and in pits, but without either, a few of the *various methods of tanning* will be of interest.

Besides the above, there exists a variety of leathers in the manufacture of which no tanning is necessary, but the skins are submitted to an operation called *tawning*, the chemical theory of which is but little known.

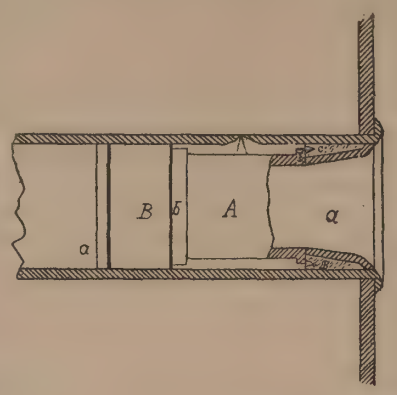
How many continually confuse the real *Russia Leather* with the imitation; or, again, imagine that *Morocco Leather* made in this country is an imitation of the genuine article. Such is not the case, as the general principle of this manufacture is the same here as in Morocco. Then *Hungarian Leather* must necessarily be made in Hungary; and *shammies* are nothing more or less than the skins of the chamois tanned. As for *shagreen*, there are but few who know the meaning of the word. It would be impossible to enter into every detail of the above, as the majority are anxious to gain information without much trouble.

The questions most generally asked are: How is grain leather made? Where was it first manufactured? If you enter into the long and tedious operations, they do not care to hear; but if a short outline and a synopsis of its manufacture be given, they are generally contented.

In the series now appearing in the POLYTECHNIC REVIEW on the Manufacture of of Leather, it is to be hoped that the above demands will be fulfilled.

McCONNELL'S TUBE LEAK STOPPER.

The accompanying illustration represents a device recently patented and claimed to be placed in position, and thereby stop the leaking of boiler tubes, even while the boiler is under full working pressure.



N is a bell shaped tube of iron provided with collars *b*, which surrounded the tube at the juncture of the bell-shaped and straight portions, and are somewhat less in diameter than the leaking tube. The rubber gaskets *B B* are placed between the stopper and the tube. The stopper is applied to the leak by being forced down the tube with a rod, and so placed that one of the collars *b* is on each side of the leak, as shown in illustration. The pressure of the steam or water, will force the rubber rings *B B* outwards and throw the flanges formed by the groove *c* against the inner surface of the tube, and thereby partition off the leaking part.

CURIOUS CASE OF SUPPOSED POISONING.

A short time ago, an aged female, paralytic for some months, suddenly died in the French commune of Saint Lyphard, after having several times vomited a liquid of intense blue colour. Rumor accused her husband of having poisoned her with a salt of copper, and Prof. Andouard, of Nantes, was called in to make an analysis of the blue stains. He sooned convinced himself that no copper was present, nor did the microscope reveal any small organism which might explain the coloration. He was led to conclude that the vomited matter consisted of bile modified in its colour by some indeterminate influence. Experimenting with the aqueous solution, he found, that both by its fluorescence and by the absorption band it gave in the spectroscope, the pigment was closely related to the products of oxidation of *bilirubin* and *biliverdin* obtained by Laffé and Stokvis and named *choleverdin* and *cholecyanin*. Its other properties established a close affinity with the pigment isolated by M. Ritter from human bile. The phenomenon does not seem to have attracted attention before from medical men.—*E. M. and W.*, xxvi 136.

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SLIDE VALVE GEARS.

By HUGO BILGRAM, M. E.

PART III.

THE LINK EXPANSION GEAR.

Problem XIII.—A valve gear of the description shuow in Fig. 71 is to be made having a range of cut-off from $\frac{1}{10}$ to $\frac{8}{10}$ of the stroke. The greatest port-opening of the main-valve is to be $1\frac{1}{4}''$, the lead $\frac{1}{8}''$, the inside lap=0. The cut-off valve is to be made in form of a frame to cut off with the inside edges, and its greatest absolute travel is not to exceed double the travel of the main valve. The cut-off eccentrict rod, which is 36″ long, is joined to the link at a point 9″ from the fulcrum. The virtual length of the link (the greates distance of the link block from the fulcrum) is 12″. The throws and positions of both eccentrics and the laps of both valves shall be determined, if it is required that at the grade of the least relative movement of the cut-off valve the time for closing the last half inch of the port of the main valve shall be as short—*i. e.*, that the relative velocity of the cut-off valve $\frac{1}{4}''$ before the closure shall be as great—as possible.

The diagram of the main-valve, cutting off at $\frac{8}{10}$ of the stroke and giving $1\frac{1}{4}$ port-opening and $\frac{1}{8}''$ lead, is found first, as usually, and the next thing is to determine the locus for

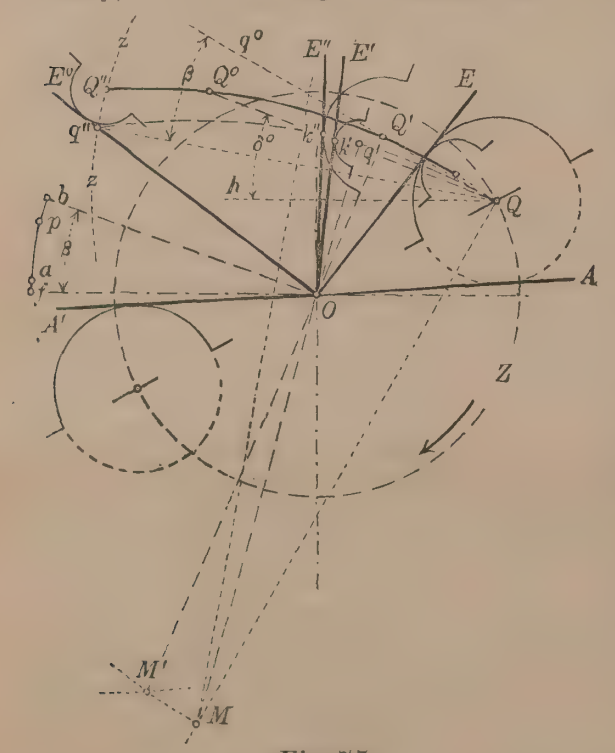

Fig. 75.

the cut-off (compare with Fig. 74). If we first assume the slot of the link extended to the fulcrum, the curve will start at the centre Q (Fig. 75). Since the greatest absolute travel of the cut-off valve is required to equal twice that of the main-valve, we sweep from Q, indefinitely, the arc z with a radius equal to twice the distance OQ. In this arc the locus will terminate. We also determine the crank-angle $OE°$ for the earliest cut-off, and assume, for a start, the lap of the cut-off valve equal to zero, in which case the point q'', the intersection of the lines z and $OE°$, will the be outer end of the locus. Next we bisect the distance $q''Q$ perpendicularly by a right line, in which the centre M of the arc must lie. Thereupon we find to total angle of variation, β, of the eccentric rod by making $fO=bO=36$, (to reduced scale) and $fb=12''$ and then by copying $q''Qq°=\beta$, we obtain $Qq°$, which must be a tangent, in Q, of the locus. The centre M can therefore be finally located by the line QM, forming right angles with the line $Qq°$, and the locus $q''Q$ can be drawn.

By drawing a line from M through O, we find the point q' of this arc, representing the least relative travel of the cut-off valve, and sweeping, from q', a circle of a radius of $\frac{1}{4}''$, we obtain the crank angle $OE'°$, for which the opening of the steam passage is $\frac{1}{4}''$, and Ok' represents the velocity. After assuming different laps for the cut-off valve and repeating the foregoing proceeding, we can select from the various attempts that one which gives the greatest velocity. Let us assume, for instance, a positive lap of $\frac{3}{8}''$, it is obvious that Q'' (Fig. 75) of the new locus, must be $\frac{3}{8}''$ from the line $OE°$. The new centre M' of the corresponding locus is found by the intersection of indefinite arcs of equal radii swept from Q (through M), and from Q''. The centre Q'_1 of the least relative travel, of the new locus, can again be found by a line from M' through O, and a circle of a radius of $\frac{5}{8}''$ (lap plus $\frac{1}{4}''$) gives us the sought velocity, Ok'', by a tangent from O, which it will be seen, is greater than the result of the first attempt. A further increase or reduction of the lap of the cut-off valve, will be found to furnish less favorable results whence the assumption of the last attempt should be adopted.

The angular advance and the throw of the cut-off eccentric remain yet to be determined. To this end we locate the point p of the link where the eccentric rod is attached, and by dividing the locus $Q''Q$ in the same proportion as this point divides the link, we find the point $Q°$ representing the action of the valve while the eccentric rod is in line with the link-block. Hence the distance $QQ°=3\frac{3}{16}''$ is the throw, and the angle $\delta°$ the angular advance of the cut-off valve. The latter is negative, showing that the cut-off eccentric is located somewhere like $i°$ of Fig. 59. The throw of the main eccentric is $2\frac{1}{8}''$, the lap of the main valve=$\frac{7}{8}''$, and that of the cut-off valve=$\frac{5}{8}''$.

In proportioning the cut-off valve we must observe that the plates are made long enough to prevent the outside edges from opening the passages of the main valve before the latter has closed the respective port of the cylinder. The relative movement of the cut-off valve (for the grade Q'') at the moment the main valve closes the steam port, at E, is equal to the distance of Q'' from the line OE, which is very nearly equal to the greatest relative movement, $OQ''=3\frac{1}{8}''$ the cut-off valve ever attains, hence the outer lap of the cut-off plate should equal $3\frac{1}{8}''$, with an addition of at least $\frac{1}{4}''$ to secure a seal. To keep the inside edge of the *wrong* plate from covering the passage of the main valve after the latter begins to admit steam, we measure the relative movement of the cut-off valve for the crank-angle of admission, OA' which is the distance of Q' from this line,=$2\frac{3}{8}''$ about, and see that the inside edge of the *wrong* plate, in its neutral position, will be at least this distance from the passage; and as the lap of the cut-off plates is $\frac{3}{8}''$, their clear distance should be at least $\frac{7}{8}''$. In the present case, however, this distance will have to be greater, for other reasons, and there is no fear, therefore, of one plate interfering with the duty of the other.

The diagram shows very fair figures as regards the rapidity of the cutting-off, owing to the limited range of expansion. This valve-gear would, in fact, not answer when adjusted by a governor, since the shortest attainable admission, $\frac{1}{10}$ of the stroke, would make the engine run away when without and or with but a light load.

Supposing the engine was running, the cut-off link should have the fulcrum on its lower end, since the cut-off plates are cutting off by their inside edges. The highest position of the link is found by sweeping from the proper point of the locus a lap circle of $\frac{5}{8}''$ radius, tangential to the line OE, the position of the centre of which determines the lowest point, a, of the link, which is found to be so near to the fulcrum that the latter should be secured to the link by a bridge.

This valve gear can be made serviceable in connection with a link-motion only by making the valve as in the last problem, of two plates cutting off with their "inside edges," since otherwise the cut-off valve, negative lap notwithstanding, would invariably cut off at a very early point of the stroke when the link of the main valve is reversed, the locus assuming the position $Q'Q°$, in Fig. 76, while if the valve is made

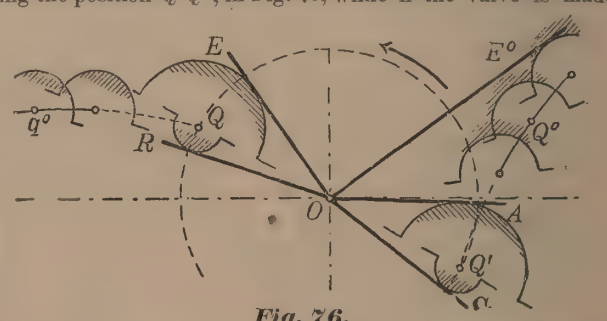

Fig. 76.

as said, the locus will be in $Qq°$, showing that the cut-off valve even with positive lap, will not cut off at any grade before the main-valve closes the steam-ports of the cylinder. For backward motion, then, we have to avail ourselves of the link-motion of the main-valve when we desire to vary the cut-off, and this style of valves can therefore be used to advantage only on engines which are mostly running forward, as is the case with marine engines.

A few words on the correction of the unequalities of the fore and return-stroke may be added in conclusion. This valve-gear offers facilities for correcting the cut-off for every grade, as the necessary lengthening of the valve stem can be accomplished by a deviation of the curve of the link from the form defined by the foregoing discussion, and since every grade corresponds to a different point of the link, the precision of a correction throughout the whole range is only dependent on the accuracy of workmanship. The finding of the proper curve of the link will offer no difficulty, if the former discussions on the subject are duly considered.

(To be continued.)

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Nitro-Glycerine as an Explosive.—The temperature developed on the explosive combustion of nitro-glycerine has not been accurately ascertained, but as the combustion is much more perfect than is the case with gunpowder, it is probably much greater, and has been assumed to be more than twice as great. One volume of powder gives 190 volumes of gas at the ordinary temperature; in consequence of the heat developed, this gas expands to four times this volume, giving 760 volumes of gas directly after the explosion. One volume of nitro glycerine gives 1300 volumes of gas at the ordinary temperature, and assuming as pretty nearly correct that the heat developed is two and a-half times as great, we should have the gases expanded to ten times their volume at ordinary temperatures, of 3,000 volumes of hot gas; so that according to volume the strength of the nitro-glycerine is seventeen times that of gunpowder. But in consequence of the enormous velocity of combustion of nitro-glycerine, its impact effect is still more increased. With nitro-glycerine larger masses of rock can be operated on at one blasting, in consequence of the severe shattering power which its rapid combustion confers upon it. At the slate quarries in North Wales, where nitro-glycerine was for some time used, a single blast with nitro-glycerine sufficed where previously four or five blasts with gunpowder were required. Similar favorable results were obtained at Freiberg and in Belgium.—*Engineer, xliv*, 275.

The Electric Light at the Paris Exhibition.—A special division of the Paris International Exhibition will be devoted to electricity, so that all the systems of electric lighting may be tested comparatively. The electric light continues to create the greatest interest in Paris. The experiments which we mentioned some time ago have been conducted during forty consecutive days at the Lyons railway station. A force of about 40 horse-power is sufficient to keep going twenty-eight electric lamps, each of which gives a light equal to eighty gas lamps, and works with regularity for ten and a half hours. The effect is splendid, the whole of the station, except the waiting-room, being lighted *a giorno*. The question of economy, however, is not yet settled. It is not known whether the company will agree to pay a somewhat higher price in order to multiply the power of its illumination. These experiments have been tried on Lontain's system, a modification of Wilde's and Siemens' principle. M. Lontain has contrived to send the current generated by an ordinary Wilde's machine into an electro-magnetic engine called a distributor. The central part being strongly magnetised by the current from a Wilde's machine, a number of electro-magnets are influenced by its rapid rotation, and in each of these an induction-current is generated. These induction-currents are powerful enough to feed three electric lamps, and as there are two series of twelve magnets a single machine could, theoretically, feed seventy-two lamps. Actually, however, it feeds only twenty-eight. Lontain uses a new regulator, which works very well by the dilatation of a small silver wire. By its dilatation this part of the apparatus works a lever system, and brings the carbon electrodes into contact. The French Northern Railway has purchased a number of Gramme magneto-electric machines. They intend to use them at their terminus goods and stores.—*Nature, xvi*, 530.

The Reduction of Aluminium.—In the almost only factory for the production of this metal, in Salindres, near Alais, the mineral Bauxite is heated with soda in a reverberatory furnace, the resulting aluminate of soda is extracted by means of water and alumina, precipitated by a stream of carbonic acid; this is then formed into balls, with salt and coal and heated to a white heat in vertical retorts during the introduction of chlorine gas. The double chloride of soda and alumina, which distills over is fused with the addition of 35 per cent. of sodium and 40 per cent. of cryolite as a flux, and the metal which settles at the bottom of the crucible is poured into moulds.

The cost of producing 1 kg. of aluminium is 80 frcs.; while the selling price is 100.—*Dingler's Journal per Berg u. Huetten. Ztg., xxxvi*, 207.

Vitreous Phosphate of Lime.—The acid phosphate of lime, described by M. Sidot, is crystallized under the influence of heat. If exposed to a very high temperature, it becomes perfectly vitrified, abandoning part of its elements and descending probably to the condition of tri-basic phosphate of lime, $3CaO, PO_5$. It has great refracting power, its index being 1·523; its density, 2·6. It can be worked like common glass, to form lenses, prisms and brilliants, with a strass-like lustre. It resists cold acids, but is attacked by boiling acids and by potash. This property may render it valuable in the art of engraving on glass.—*Les Mondes, per Journal of Frank. Institute, lxxiv*, 315.

Ironclads should be handled about as carefully as glass when the mercury is many degrees below zero. The Russian government is bemoaning the folly of the Grand Duke Constantine in not realizing the effect that would probably result from the vibrations of cannon firing on board of a monitor when the iron composing the hull and machinery was under the influence of a severe frost. Last winter, when the Baltic was frozen over, and solid ice kept the Russian fleet still and motionless within the harbor at Cronstadt, the Grand Duke, fearing the crew of the ironclad Peter the Great would be unprepared for any emergency which might occur in the spring, issued orders for the officers and men to pass through a series of gun drill. Three out of the four 35-ton guns belonging to the monitor had been dispatched to the Black Sea for the defense of Odessa, so that the practice could only be carried on with one. The result of the firing has been made apparent in the discovery of the porosity of the hull, the cracking of cylinders and the fracturing of other portions of the machinery. A committee of naval experts examined the boat and experienced no difficulty in arriving at the cause of its terribly damaged state. There was an Arctic temperature of 40 and even 50 deg. below zero at Cronstadt very frequently last winter.—*Iron Age.*

Flooring Tiles of Asphalt.—The London *Building News* states that at the Bavarian Industrial Museum may be seen a collection of square tiles of asphalt prepared by a new process, and intended for floorings. The tiles are ornamented with mosaic, in white china or colored glass, which may be arranged according to any design. The drawing to be reproduced is traced on a sheet of thick paper, which is afterward covered with the various fragments of china or glass, which will form the mosaic; a border is made to the sheet, and boiling asphalt poured upon it. After the whole is cooled, the paper is taken away with cold water, and the tile is finished. A flooring covered with such tiles bound together by a string of asphalt appears to have been made by a single melting, and has a good appearance. It indefinitely resists dampness, and is consequently useful in bathrooms, halls of houses and balconies.—*Mining and Scientific Press, xxxv*, 259.

Incombustible Silicate Board.—The preparation of *carton silicate incombustible*, especially intended for the covering of roofs, consists in saturating the alternate layers of paste-board respectively with silicate of soda and a solution of chlorate of barium or other salts which produce insoluble silicates, such as calcium, aluminium, magnesium, iron, lead, or zinc salts.

The entire mass of the board is consequently saturated with silicate of barium, or some other equally insoluble salt, and silicic acid. These materials form in the interior of the board as well as on the surface, an insoluble compound which preserves it from all atmospheric influences and makes the entire mass incombustible.

These solutions can be applied to the material during the manufacture of the board as well as to the finished product. The treatment is suited for paper, wood or textile fabrics. The silicate board is subject to any coloration and possesses great tenacity and durability with lightness. It is said to cost but little. The invention was patented in March, 1876.—*Bulletin du Museo de l' Ind. de Belgique, per Papier Ztg. ii*, 652.

Blue Ink.—Take Berlin blue, 6 parts; oxalic acid, 1 part. Mix thoroughly into a soft paste, with water. Dissolve in rain-water, and add a little gum arabic.—*Fortsch. d. Zeit.*, per *Jour. Franklin Institute, lxxiv*, 299.

Kangaroo Leather.—Kangaroo hides have already become an important article of export from Australia. They make the most pliable leather that is known, admirably fitted for boot-legs, gloves, and riding whips. The skins are sent to Europe, some tanned, and some simply dried.—*Fortsch. d. Zeit., per Jour. Frank. Institute, lxxiv*, 334.

A Severe Earthquake Shock was lately felt at Geneva. Clocks were stopped, bells were rung, buildings cracked, and the English and Russian churches were rather shaken. No great damage was done. The shock extended to Berne, Mulhouse and Malesina in North Italy.—*Nature, xvi*, 514.

New Laboratory Burner.—M. Godefroy uses four metallic cylinders, one within another; the first and the third are pierced with holes at their base. The spaces between the cylinders communicate, one set with two vertical pipes, uniting in a horizontal pipe below, the other set with another similar system. A piece of metallic net at the lower part, regulates the entrance of air.—*Nature, per Journal Franklin Institute*, lxxiv, 296.

ENGINEERING—CIVIL AND MECHANICAL, &c.

Submarine Engineering.—Particulars of the submarine cables now in existence have been stated as follows, by the Director of the Bureau International, at Berne, Switzerland: Private companies—Number of cables, 149; miles of cable, 59,547; miles of wire, 5,725. Totals, 569; 63,989; 71,262. The last total shows the extent of active wire as distinguished from the mileage of cable, some of them bearing as many as seven conductors. These figures give an average length of 112 miles for each cable, the average of the governments being under 11, and that of the private corporations close upon 400 miles. The enumeration includes all wires laid in bays, gulfs, or estuaries on the coasts of the various countries, but excludes any laid across interior lakes or water-courses. In the north of Europe, the Government system of Norway embraces no fewer than 193 cables, each carrying one wire and only making up an aggregate of 233 nautical miles in length. In Sweden, besides the joint possession with Germany and Denmark of submarine cables joining the Scandinavian Peninsula with the European systems, the Government has four cables, of an aggregate length of 22½ nautical miles. Denmark has in its system twenty-nine different cables, with a total length of 101 nautical miles. Holland possesses in all, eighteen submarine cables, with an aggregate of 36 nautical miles, the longest being 16 miles. Although Russia possesses a telegraph second only in point of extent in Europe, to that of the United Kingdom, the geographical formation of that vast empire is such that it only possesses three submarine cables, of 62 miles in all, besides its one-half share in the Crimea and Caucasus line. The cables of Germany in the North Sea and Baltic, and of Austria, in the Adriatic, are forty-six in number, and 235½ nautical miles in extent. Italy has twelve cables in all, one of them being 118 miles long.—Spain has six, extending to 283 miles. The twenty-six cables of France are mostly short, though one of them—that from Marseilles to Algeria, 500 miles—is one of the longest in any national system. Great Britain, with Ireland, has forty-nine cables, with a total length of 500¾ nautical miles, in addition to being owner of three cables to the Continent from the Norfolk coast, embracing 460 miles additional. Portugal is the only European nation which possesses no Government submarine telegraph.

The construction of most of the private lines has been due to British capital and enterprise. The Anglo-American Company has the longest submarine cable in the world (Brest to St. Pierre, 2585½ nautical miles), and a group of five Atlantic cables in all; yet the total length of its cables is exceeded by the system of the Eastern Telegraph Company. The seventeen cables of the former extend in all to 12,315 nautical miles, the longest of the subsidiary lines used to join those from Europe at the insular shore ends on this side, being that from St. Pierre to Duxbury, Massachusetts, with a length of 749 miles. The Eastern Company has, including the Eastern extension, a total of 21,883 nautical miles, being about one-third of the whole existing in the world. The original enterprise presented a total of thirty-nine cables and 14,502¾ nautical miles, and the extension nine cables and 7,381 miles. Next in point of extent are the systems of the West Indian and the Brazilian Companies, the former having nineteen cables with a total of 3,970 miles and the latter three cables and 3,866 miles. If the landings at Madeira and Cape Verde Islands are left out of view, the line from Portugal to Brazil may be looked on as the longest cables in the world. These two systems—the West Indian and the Brazilian—are united by the limits of the Western and Brazilian Companies with nine cables of a total length of 3,750 nautical miles. Next to the French-Atlantic cable the longest unbroken line of submarine wire is the cable of the Direct United States Company, from Ballingskelig's Bay, County Kerry, Ireland, to Tor Bay in Nova Scotia, which is 2,429 nautical miles in length.—*Iron x.* 459.

MINING, METALLURGY AND MINERALOGY.

A Petroleum Geyser.—In sinking an oil well recently about five miles north of Wilcox, Elk County, Penn., an intermittent flow was struck which presents many of the features of a geyser. The well spouts for two minutes, and then is quiet for eight minutes. During the spouting it sends up salt water, inflammable gas, and a small quantity of oil to a height of 150 feet. By lighting the gas at night a magnificent spectacle is obtained, the gas burning brilliantly and illuminating the column with prismatic hues. The roar of the burning gas is said to be audible within a radius of some miles. In the city of Earle, Penn., the flow of gas from wells is largely utilized for heating and illumination; the product of not fewer than fifteen wells being thus employed.—*N. Y. Tribune.*

Unexpected Gold Discovery.—In the town of Auburn, Oregon, gold diggings have been found under peculiar circumstances. A boy had been fitted out by his father with the implements of mining and set to work near the roadside, merely for amusement and to give the youngster something to keep him out of mischief. The ground was staked out formally in mining style, and some waste water was turned into sluices so as to wash the dirt. The boy worked for a few days faithfully, and, to everybody's surprise, he at last panned out a small quantity of gold dust. Laborers were then employed, and the work was deepened and extended, gold continuing to be found, and at last accounts, in profitable quantities.

—A vein of natural gas was struck on October 19 at a depth of twenty feet, on the property of the McKeesport Tin Works, in McKeesport. The gas rushed forth with great noise, and when the temporary tools used in prospecting were removed, one of the workmen incautiously applied a match, and in an instant a sheet of flame shot up. He narrowly escaped being burned to death. The company will proceed, at once, to put down a well and make a thorough test.

—Edward Shelley writes the *American Manufacturer*, Pittsburgh, a glowing account of the mining wealth of Southwestern Virginia. Iron, copper, lead and zinc ores are found in abundance. Gold and silver quartz mines of great richness are also found, and some of the most valuable mica mines are found in the same region.

—In July, the exports of coal raised from the mines of Great Britain reached 100,000,000 tons in a year, for the first time in 1866. In 1876 it amounted to 134,125,166 tons, namely 115-334,359 tons, in England and Wales, 18,665,612, tons in Scotland, 125,195 tons in Ireland. Durham, the greatest coal field, keeps its lead, its year's product now approaching 26,000,000 tons. Wales produced above 19,000,000 tons.

—The Montreal *Journal of Commerce* says a valuable discovery of silver has been made at St. George, N. B., on an island in the river. Some United States citizens secured the property, and have taken out about two tons of ore, each barrel of which is said to be worth $500. The people of St. George are getting excited over the discovery, and the neighboring country is thoroughly searched for the precious metal.

—The *Mining Journal* estimates that the lake shipments of iron ore will not exceed 875,000 gross tons at the close of the season.

—It is stated that the area of the gold mines in Russia is a little over 2,000,000 square miles. The yield is about 80,000 pounds in weight annually, equivalent, on an average to $15,-000,000.

MISCELLANEOUS.

Cost of the Electric Light.—It appears to be difficult to arrive at the cost of using the electric light, figures of estimate in different experiments varying considerably. In many manufacturing establishments the cost of the power to drive a magneto-electric machine would scarcely be felt, as only two or three horse-power, at the most, would be required. The cost of the carbons is said to be less than five cents per hour, per lamp on the Jablochoff plan; another estimate is about twice as much, but perhaps refers to two lamps instead of one. An electric light which does not, according to accounts, appear to be constructed on the Jablochoff plan, tested in practical service at LaChabelle, France, costs, including motive power for the machine, about twelve cents per lamp per hour. Machines capable of running three lamps, cost less than $500, and perhaps that sum could be made to cover all the first outlay. The wear and tear of the machine is not estimated. A careful study of the figures thus far furnished, leads to the belief that light can be furnished by electricity, in France, at about two-fifths the cost of gas; and as the price of gas in most American cities exceeds the price in Europe, it seems probable that a similar estimate of the comparative cost of electric illumination for this country would fairly apply.—*N. Y. Tribune*,

Measuring Vibrations—A brief essay was delivered by Professor Alfred M. Mayer, on a new and simple method of determining the number of vibrations of sonorous bodies. He described several of the methods in use, speaking with especial satisfaction of his own plan (described last year), in which a tuning-fork is armed with a piece of metallic foil, that scrapes a line upon a smoke-blackened sheet on a cylinder revolving by clock-work. The seconds' beat of a clock can be made by electricity to send a spark through the metallic foil, thus burning a hole in the smoke-blackened sheet at each interval of time. The line made on the sheet by the foil is sinuous, and shows the number of vibrations between the second-holes, by the intervening number of sinuosities or waves. But the new contrivance is much simpler, as regards the measurement of time. It is a kind of syren, made simply by punching holes near the edge of a circular card, and setting the card in revolution. While the card is going round, it is only necessary to hold a pipe opposite the holes. The note sounded by this pipe determines the rate of revolution. This method can be easily adopted in lieu of using a seconds' clock, and gives results that are nearly accurate, with very little cost or trouble.—*N. Y. Tribune.*

The Culture of the Eucalyptus.—The following notes from a report on the culture of the Eucalyptus in Algeria by Consul-General Playfair will, no doubt, be interesting. With regard to rapidity of growth, it seems that the first trees ever planted in Algeria were sown in 1862, and upon being measured in 1874, that is at twelve years of age, gave a circumference at one meter from the ground of 1.52 meters, another of eleven years' growth gave 1.42 meters, and and another, planted in fresh alluvial soil, nine years of age, gave 1.57 meters—about six inches more, Col. Playfair says, than he could embrace with both arms. To the question of the sanitary effects of the Eucalyptus a good deal of attention has been directed. An inquiry was instituted by the Society of Physical and Natural Sciences at Algiers under the presidency of Dr. Betherand, and the result was that from thirty localities reports were received, all of which speak favorably of the Eucalyptus as a fever preventive. On the banks of Lake Fetzara, near Bone, 60,000 young trees of *Eucalyptus Globulus* were planted in 1369. At the present time they have attained a height of from 7 to 8 meters each, and have, it is said produced a very marked effect on the locality. Such was the feverish condition of this district on the annual fall of the water and the denudation of its banks that the director of the Jardin d'Essai, who went to examine the condition of the plants, was immediately seized with a violent fever which lasted twenty days, This gentleman, however, now reports that the miasmatic influences which effected him so strongly then have disappeared, and the musquitoes which rendered the place inhabitable have disappeared with them. At the great iron mines of Mokta et Hadid it was formerly impossible for the workmen to remain there during the summer; those who attempted to do so died, and the company was obliged to take the laborers to the mines by train every morning, and to carry them back to Bone at night, a distance of 33 kilometers each way. From 1868 to 1870 the company planted more than 100,000 Eucalyptus trees, and now the workmen are able to live all the year through on the scene of their labor. Consul Playfair advances the following reasons as accounting for the causes of the improvement in climate from planting Eucalyptus trees: "In some places," he says, "the trees destroyed miasma by utilizing moisture of the soil in which they were planted, and thus drain marshes; the emanations from their leaves also may have produced a salutary effect. They contain a large quantity of essential oil very similar to turpentine, which they emit in great quantities, especially when stirred by the wind, and this acts, it is supposed, as a febrifuge." We are further told that considerable numbers of Eucalyptus have been planted all along the railway from Algiers to Oran. Where this line passes through the Metidja the trees have grown successfully, but in the Chelif they have proved an entire failure. This, however, may have been due to their receiving no attention whatever after being planted.—*Nature*, *xvi*. 559.

Improved Carmine Ink.—The solubility of carmine lake in caustic aqua ammonia is attended with this disadvantage; that in consequence of the alkaline properties of ammonia, the cochineal pigment will, in time, form a basic compound, which in contact with a steel pen no longer produces the intense red, but rather a blackish color. To avoid this evil, prepare the ink as follows: Saturate 1 gramme of pure carmine with 15 grammes of acetate of ammonia solution and an equal quantity of distilled water in a porcelain mortar, and allow the whole to stand for some time. In this way a portion of the alumnia which is combined with the carmine dye, is taken up by the acetic acid of the ammonia salt, and separates as precipitate, while the pure pigment of the cochineal remains dissolved in the half saturated ammonia. It is now filtered, and a few drops of pure white syrup added to thicken it. In this way an excellent red drawing ink is obtained, which holds its color a long time. A solution of gum arabic cannot be employed to thicken this ink, as it still contains some acetic acid, which would coagulate the bassorine which is one of the natural constituents of gum arabic.—*Eng. Mech.* xxvi, 163.

Fire Brick Manufacture.—At New Cumberland, on the Ohio, a short distance below the Pennsylvania line, in West Virginia, Messrs. Smith, Porter & Co., are manufacturing fire brick with natural gas, from a well near by. We are informed that this is the first fire brick ever burned without wood or coal. In this yard they have 9 kilns, all burning from the same well, which also supplies flames to run three engines, and ten furnaces in the drying house; and besides this large consumption several dwellings are supplied with gas for fuel and lights, and still there is a large surplus from the same well, unused except from the top of an escape pipe to light up the surrounding country. The fire brick manufactured in this way are said to be of a superior quality; fifty-five thousand are made daily. —*Hardware Reporter.*

Coggia's Comet is still approaching the earth, and increasing in apparent brightness, but Tempel's is receding and becoming fainter. It is noted as singular that the latter was not earlier discovered as it was bright, with a well-defined nucleus when first seen.

Swedish Polar Expedition.—In a report to the Swedish Government, by Prof. Nordenskjold, with reference to next year's expedition to the Glacial Sea, of Siberia, that explorer announces his programme. He urges, *inter alia*, that the ocean north of Siberia has never been traversed by a properly equipped ship, still less a steamer; that the small vessels used have never been able to venture far from the coast, and that they have always sought a wintering harbor just at the time when the sea is freest of ice—viz., in the autumn; that nevertheless, the sea extending from Cape Tscheljusgin to Behring's Strait has been traversed in several successive voyages, but never all at once; that the winter ice formed along the coast, which does not extend very far, is broken up every year, producing large fields of floating ice, which is driven sometimes southward, sometimes far northwards; whence it seems probable that the Siberian Sea is separated from the Polar Sea proper by a series of islands, of which we at present know only Wrangel Land, and the large island forming New Siberia. The Professor thinks, then, that a rightly equipped steamer might, without great difficulty, make the voyage referred to in autumn, and that, in any case, the thorough exploration of this almost virgin sea would be a great gain to science. In case the complete voyage should prove impracticable, the expedition will remain at some point on the north coast of Siberia, suitable for scientific exploration. The coast beyond the mouths of the Yenisei, the flora and fauna of the sea in this region, the present and past condition of the Polar regions, the types of animals of glacial origin, as compared with those of Atlantic origin, the mammoth period in Siberia, and its conditions, the magnificent remains of plants in polar rocks, the meteorological phenomena of those regions, &c., combine to present a very rich field of investigation.—*English Mechanic*, xxvi, 164.

The Silk Industry.—Evidences of the growth of the silk industry of the United States, under the beneficent policy of protection, are being constantly presented from all quarters. The latest testimony is from the United States Consulate at Lyons, France, which shows that, for the year ending Sept. 30, 1877, as compared with the preceding year, there was a decrease in the exportation of silk goods alone from that port to the United States, of $1,730,370, more than one-fifth of the whole export of these manufactures. An increase in the export of raw silk to the United States of over $500,000 (more than the entire export of the previous year) is noted, showing that the decrease in the exports of silk manufactures was owing to the increase in our home manufactures. A general decline in the silk manufactures at Lyons is reported, owing partly to dull markets, but more particularly to German and Swiss competition, and the increase of silk manufactures in the United States.—*Com. Bulletin.*

Experimental Trial of Prof. Gorini's Crematory apparatus, was made at Lodi, on the 9th inst., in the presence of Dr. Bono, delegate of the Town Council of Milan, Dr. Nardi, of Milan, and a number of representatives of different bodies, including the press. A body weighing 42 kilos. was completely incinerated in two hours at an expenditure of 200 kilos. of wood. The remains were equivalent to 5 per cent. of the original weight. Not the slightest fœtor or disagreeable sensation was experienced by the bystanders, who endorsed the remarks of Dr. Bono when he congratulated Prof. Gorini on the invention of the most expeditious and satisfactory apparatus yet devised for the purpose.—*English Mechanic*, xxvii 164.

Famous Bells.—The following is from the new edition of the *Encyclopædia Britannica*: "The great bell at Moscow, Tzar Kolokol, which, according to the inscription, was cast in 1733, was in the earth 103 years, and was raised by the Emperor Nicholas in 1836. The present bell seems never to have been actually hung or rung, having cracked in the furnace. Photographs of it are now common, as it stands on a raised platform in the middle of a square. It is used as a chapel. It weighs about 440,000 lbs.; height, 10 feet 3 inches; circumference, 60 feet 9 inches; thickness, 2 feet; weight of broken piece, 11 tons. The second Moscow bell, the largest in the world in actual use, weighs 128 tons. The great bell at Pekin weighs 53 tons; Nanking, 22 tons; Olmultz, 17 tons; Vienna (1711), 17 tons; Notre Dame (1680), 17 tons; Erfurt, one of the finest bell-metal, 13 tons; Great Peter, York Minster, which cost £2,000 in 1845, 10 tons; St. Paul's, 5 tons; Great Tom, at Oxford, 7 tons; Great Tom at Lincoln, 5 tons; Big Ben, of the Westminister clock tower (cracked), weighs between 13 and 14 tons; it was cast by George Mears, under the direction of Edward Beckett Denison, in 1858; its four quarters were cast by Warren in 1856. The Kaiserglocke, of Cologne cathedral, lately recast (1875, weighs 25 tons."

—A case of practical evolution was accomplished by a German lady with three Mexican salamanders—changing an amphibious double-breathing animal, into a lung-breathing and land-inhabiting one.

—136,000 old models, with the 49,000 rejected ones, were destroyed by the late fire at the Patent offices. The *Scientific American* takes the opportunity to advocate that the patent laws be amended to dispense with models.

Labor Saving Machinery in Massaschusetts.—A feature of the Massachusetts census of manufactures for 1875, deserving especial notice, is the showing made in regard to the effect of labor-saving machinery on the production of some of the leading staples. We find that, with 24,151 hands employed in 1865, there was produced 175,875,000 yards of goods, a ratio of 7.355 yards to each employee. In 1875 there was produced 874,780,000 yards by 60,176 employees, or about 11,213 yards to each hand. This shows that with an increase of a little over 149 per cent. during the ten years, in the number of hands employed, the quantity of cloth produced was increased nearly 392 per cent. Woolen goods also make a very striking exhibit. For 1865 the production is placed at 46,008,141 yards, and the number of employees 18,753. For 1875 the production is 90,208,280 yards, and 19,036 employees, showing an increase of 96½ per cent. in production to 1½ per cent. in the number of employees The number of pairs of boots and shoes made in 1865 was 31,870,581, and number of employees 52,821, and in 1875, 59,762,866 pairs with 48,090 employees.

This is probably the most important showing made, the production during the ten years having been increased nearly 88 per cent., while the force employed was less by 4,731, The product of carpetings in 1875 increased fourfold as compared with 1865, while the increase of force employed was less than half that amount. The average value of the boots and shoes produced in 1845 was 70 cents a pair in 1855, 80 cents; in 1865, $1.80. and 1875 $1.50. The value of carpetings was $2 per yard in 1685, and less than 73 cents per yard in 1875—which shows the source of the immense supply of dollar carpetings. The great reduction in the number of employees in the clothing business shows to what an extent the sewing machine, the machine shear and more careful gradations of "ready-made" have superseded the need of the tailor and the needle woman.—*N. Y. Daily Bulletin.*

Tattooing a Contagious Disease.—One of the most curious cases of spreading a disease of offensive and contagious character has lately been brought to light by Dr. Maury, of the Philadelphia Hospital.

Attention was attracted to the case some time ago, by the large number of persons who were admitted to the hospital suffering from this disease, and who had been inoculated with it through the process of tattooing. Shortly thereafter it was ascertained that at Reading, Pennsylvania, some two or three hundred persons had been similarly inoculated, and that it was the work of a notorious vagabond, who practiced tattooing as a trade. Through the efforts of the police authorities this person was shortly thereafter arrested at the instance of the health officers of the two cities. Medical examination revealed the fact that he was afflicted with the disease and it transpired that in performing other operation of tattooing, he was in the habit of moistening his needles, before charging with paint, by placing them in his mouth, which was filled with sores.

Discovery of a Second Specimen of Archeopterix.—One knows that the archeopterix is that extraordinary reptile-bird, the narrow tail of which, long and subtle as that of the lizard or rat, is supplied at each side with a long row of feathers. The only specimen of this antediluvian animal, which gives to the wings and the feathers the character of the order of saurians, was discovered some twenty years ago by M. Ernst Haeberlein in the lithographic stone quarries of Papenheim, near Solenhofen, since then this savant has been constantly searching for more imprints of this animal, and has at last succeeded in finding another specimen more beautiful and complete than the last. The head is in a perfect state of preservation and admits of more definite determination of the species.—*La Nature*, *v*, 318.

"Pferdeschoner."—Some time ago the German government caused experiments to be made with a peculiar kind of apparatus invented by M. Fehrmann, and called a "pferdeschoner." It is for the purpose of diminishing the fatigue of horses in drawing vehicles, as also the chances of rupture of the shaft or traces. It consists of a number of India-rubber rings, separated from each other by iron rundles, the whole being contained in a cylindrical metallic case—a metallic rod, fixed to the last rundle and traversing the case, being the means of compressing the caoutchouc rings.

The length of this arrangement is 0.30m. Two are required for each horse. They are interposed between the traces and the trace-hooks, thus forming an elastic pad between the horse and the weight to be drawn. In commencing to pull horses do not make a gradually increasing effort but generally precipitate themselves on their traces with a sudden shock, wasting their strength and probably doing themselves injury.

Now the apparatus in question remedies the difficulties named by the gradual compression of the caoutchouc rings—the initial effort required of the horse is less and then it progressively increases. The experiments showed this initial effort to be only 0.38 of that without the apparatus; the mean effort of traction 0.82 of that without the apparatus; while the variations of this effort in the one case were only 0.66 of the oscillations which occurred in the other. The numbers refer to a walking case; with trotting they were respectively 0.59, 0.80 and 0.78.—*Am Manufacturer.*

Travels of the Potato Beetle.—Captain John Evans, of the schooner H. E. Riley, informs us that on a recent trip from Cienfugos, Cuba, to Boston, when fully 100 miles from land, east of the capes of Virginia, his vessel was boarded by a party of several hundred Colorado potato beetles. This was about October 8th, and there was a heavy wind from the north-northwest. A few days previous he had encountered the cyclone, which people of the coast remember well as having prevailed about that time. The insects were evidently aided in their journey to this distance from land by the wind. Some of them were thrown overboard, spread their wings before reaching the water, and flew about easily, a few returning to the vessel.

This incident shows that insects may thus be blown far to sea, and alighting upon vessels, be borne to Europe or other countries, in spite of precautions against their introduction aboard ship. Captain Evans says that he has seen potato beetles in large numbers on the decks of vessels at Philadelphia and New York, without regard to their presence in freight packages. In the case of steamers which make the voyage to Europe in ten to twelve days, it is quite possible for the beetle to live, it seems to us, on such fare as he would find aboard, and walk out smiling on the other shore. Or if he did, he, or rather she, would doubtless leave enough live eggs behind—even without the encouragement of a potato leaf—to insure the advent of her offspring in the new land.

Captain Beal, of the bark Neptune, Boston, informs us that on his last visit to Cuba, he heard of an insect which had attacked the sweet potato there. During his next trip he intends to investigate the relation of this chap to the gentleman from Colorado.—*Scientific Farmer*, ii, 149.

Visible Speech.—At the meeting of the Phonetic Section of the Franklin Institute, on October 31st. Mr. Edward B. Crane delivered a very interesting lecture on Visible Speech, or a system of representing to the eye the sounds heard in speaking, the invention of Professor Bell, of Scotland. The speaker illustrated the different organs used in speech, and their respective positions when engaged in the utterance of the various sounds of the language. A separate sign was used to indicate each position of the lips, teeth, tongue, palate used, and by their combination signs were produced which stood for each of the forty-one sounds heard in speech. Words constructed of these signs would not only show the sounds of which they were composed, but would also point out the position of the vocal organs necessary to produce them. Dumb persons, deaf from birth, have been taught through this method to speak so correctly that long conversations may be held with them without a suspicion being raised of their infirmity, because, in addition to their correct speech, they seldom fail to catch the words of their companion by observing the motions of the mouth. The usefulness of this invention is not restricted to teaching the dumb to speak, but is valuable as an adjunct in teaching the pronunciation of all foreign languages, or in eliminating the provincialisms of our own.—*Ledger.*

Drinker on Tunneling.—John Wiley & Sons will have ready about New Year's an important work on "Explosive Compounds, Powder, Drill, and Tunneling," by Henry S. Drinker. The volume will make a quarto of about one hundred pages with nearly a thousand illustrations, working profiles, etc. The author has information by careful correspondence, personal inspection, and other direct means. Some 1,400 tunnels are treated of, the peculiar difficulties of each are explained, and the remedies required and used are given. The list comprises tunnels from the various continents, even extending to New Zealand and Australia. The publishers propose to issue this work by subscription; the price will be about $15.

The German Subterranean Telegraph.—The *D. All. Polytech.* informs us that the construction of the subterranean line from Potsdam to Magdeburg, which is next year to be extended by way of Braunschweig, Hanover, &c., to Cologne, was commenced on the 3d ultimo; also the construction of the Hamburg-Kiel line. The fine weather permitted rapid progress of the work and makes the completion of the line by the early part of this month (November) very probable. The working of the subterranean line of Berlin-Frankfort, by means of Hughes apparatus, can be designated as being successful, and the probability of the interruption of the current by atmospheric influences is no longer apprehended.

Advertising—The New York *Graphic* is calling attention to the mistake which jobbing houses of that city are making in not using the newspapers to advertise their business. And the *Tribune* observes that there appears to be a tradition of the trade to spend money in making known its business to its customers in every way but the best way—in patronizing a multitude of papers which have no circulation; in hotel directories, albums, guides, placards, etc., which are never seen by the patronizing community.

—The preference which insects manifest for flowers, is the subject of an interesting paper, by Sir John Lubbock, in the London *Telegraph*. He favors the cultivation of flowers, though he considers them a superfluity.

Opening Africa to Commerce.—The communication from Mr. Stanley in the *Telegraph* of Thursday and Monday last, though containing few positive additions to our knowledge, are full of interest; the episode on the arrival of the starved and wretched party at Ni Sanda, is quite thrillling.—Notwithstanding the number of cataracts and rapids on the Lualaba—Congo, Stanley maintains it is well fitted to become a great commercial highway–2,000 miles of uninterrupted water communication, opening up an extent of country embracing 600,000 square miles. North of the equator it receives a tributary 2,000 yards wide at its mouth, coming from a little north of east, and which, according to our imperfect knowledge, is likely enough to be the Welle. Mr. Stanley speaks of the "infamous inaccuracy" of our present charts of West Africa, an inaccuracy which cost him the lives of many of his men, but which, no doubt, he will be able to correct. Three of Stanley's letters are dated from Nyangwe, and were written about a year ago. In them he speaks in the strongest language of the manner in which the slave trade is carried on in that region, describes the wonderful forest scenery between Tanganyika and Nyangwe, and gives some tender reminiscences of Livingstone preserved among the people, among whom the great traveler sojourned for so long. Mr. Stanley also endeavors to clear up the geography of the region between the Victoria, the Albert, and Tanganyika, showing that the most erroneous and confused ideas on the subject had been accepted mainly on the reports of natives to Sir Samuel Baker. No one now believes that the Tanganyika is connected with the Albert Nyanza, and, indeed, as Stanley suspects himself, he is, in refuting this notion, slaying the slain. From the little foretaste given us in these preliminary letters, there is no doubt that there is a rich feast in store for us of new and valuable information, and of adventure, scarcely paralleled in the history of geographical exploration.—*Nature*, xvii, 529.

Auction of Patent-Rights.—George W. Keeler, of New York, held another auction sale of patent-rights, consisting of 704 lots, Nov. 1. There was a large attendance, and good prices were realized. A lamp extinguisher brought $1,200; a blacking-box holder $560: a machine for splitting kindling-wood, $450; a folding spring bed, $900; a sponge cup, (New York State right), $225; an improved chair, (half interest), $400; an improved glue-dryer, $425; an improved lamp chimney, $250; another, $1,000; a triturator, to supersede the druggists' mortar and pestle, $400; a breech-loading toy cannon, $100; an improved bevel, $100; a new strap buckle, $175; a cheap fire-escape, $700; an improved boot-jack, $380; an improved lantern for miners' hats and conductors, $1,450 a combined scissors-sharpener, screw-driver, and button-hook, $300; a safety oil-can, $500; a double faucet for both hot and cold water (New England States), $140; an improved mechanical movement, $200; a double-bladed draw-knife, $100; a pretty device in toy-building blocks, $495; a new folding stool, $150; and a combination toy, resolvable into ten articles, (half interest, subject to a royalty of twelve cents per dozen and one-third the net profits), $1,450; a music stand, that can also be used as a nursery table, for $40; a convertible portmanteau and bath-tub, for $85. The sale realized over $18,000.—*Glass Journal.*

Employment of Pyritous Earth for the Treatment of Vine Plants Affected by the Phylloxera.—M. Dufresnoy has experimented on phylloxerous vines by treatment with three kinds of pyritous earth employed in the manufacture of alum, in proportions varying from four to ten litres per plant, according to the nature of the soil. Of sixty-five plants treated, fifty-six produced shoots of from one to two metres in length. In spite of the excellence of these results, it is probable that the pyritous earth will go the way of the sulphide of carbon and the famous sulpho-carbonates of M. Dumas.—*Revue Indus.*, viii, 418.

The Birch is a true hardy mountaineer, loving the rugged mountain side and luxuriating in the wild savage glens of the cold north. It is the last *tree* seen on approaching that hitherto inaccessible spot, the north pole, disappearing entirely at the 70th parallel. The ancient Caledonians made canoes of birch branches and bark covering the outside with skins. From birch they made every imaginable kind of implement and vessel. The writer has seen, in the remote part of the Highlands, cottages in which every utensil was made of birch, all being cut out of the solid timber in the most primitive fashion. Fancy, if ye can, ye *elite* of the modern tea drinking world, your cups and saucers composed of wood, Yet such was once the fashion, and our glorious ancestors "punch bowl" and "bicker" were made of such primitive material. It is recorded that during the years 272—300 and 310, years of great famine, the inhabitants of Britain were compelled to eat birch bark. In Sweden it has been used to mix with corn for food. In Russia and Poland this tree enters largely into the constructive arts, from the fittings and furnishing of the palace to the manufacture of the tobacco pipe.—*N. W. Lumberman*, viii, 1.

—A new man-power or baromotor, has been invented by Mr. Gaston Bozerain; the operator is relieved of the fatigue of lifting the leg, to an excessive hight.

—The discovery, by Stanley, of the Congo river, in Africa, opens a new world.....An anomaly—The markets of Germany and the rest of the world are supplied with "Dutch Pots" by an American firm.....The artificial coloring of segars is becoming quite an art; 76 per cent. of smokers prefer dark-colored and 24 per cent. light-colored.....A good show of improvement has been made in the increase of grain raised by the Indians on their reservation between 1868 and 1876—nearly five-fold.....The invention of cancelling used P. O. stamps is greatly needed to avoid their fraudulent re-use..... John Bright speaks dismally of the future of British industry. .....Scientific students are visiting the great devil-fish at the New York aquarium.....New York city is making arrangements to secure the second Egyptian obelisk..... Dr. Draper lectured on Evolution before the Unitarian ministers in an Association at Springfield, Mass., lately.....The latest news from the Howgate Arctic Expedition is that they were preparing for winter quarters at Cumberland Sound..... Fireless locomotives have been used on the streets of New Orleans, satisfactorily, for the past year. Hot water gives the motive power.....An improvement in the manner of preparing ceilings and other plaster works has been introduced in England. By this plan the plaster is prepared in slabs and fixed to the joists. Some of its advantages are that it braces and strengthens the slight timbers; it is self-supporting, and cannot become detached.....The oil flow of Titusville has undergone a change from the hill wells to the gravel pit. How considerable the deposit of oil may be no one can tell.....The *Bulletin of I. & S. Ass'n* in defining "The Balance of Trade," refers to the United States as a debtor nation, and England as a creditor nation.....The Kansas corn crop for the year 1877, is over one hundred million bushels.... The California wool clip of 1877, is estimated at 45,000,000 pounds, valued at $7,500,000.... The Connecticut tobacco crop for 1877 is said to be not only abundant, but superior in quality.....It is estimated that the American hop crop for the present year, will reach 600,000,000 pounds....The wine product of California, for 1877, is estimated at 8,000,000 gallons, valued at $3,000,000....San Francisco losses by fire, the past year, aggregate $1,005,779, and the actual insurance received was $348,130.....The value of agricultural implements and other machinery made in San Francisco last year, is stated at $4,700,000.....One establishment in Burlington, N. J., put up, the past season, 100,000 cans of green peas, and 100,000 cans of tomatoes.....Ten Texas stock growers own, in the aggregate, 1,024,000 head of cattle, besides horses and mules, and have an inclosed pasture containing 682,000 acres.....Rome, N. Y, boasts among her citizens a gentleman 7 feet 6 inches high, who weighs 600 pounds, and his shoes are made on a pair of lasts 22 inches long.....Between five and six million dollars are invested in the cotton mills of Lewiston, Maine, over half a million of which is owned by citizens of Lewiston and Auburn.....During the year ending June 1, 1877, over 12,000,000 pounds of dried apples were exported from this country—nearly twenty times as much as were exported the year previous,.....A large reservoir, with a capacity for receiving 200,000,000 feet in logs, has been constructed on the Chippewa river, about four miles above the town of that name in Wisconsin.....At the recent fair or the Mechanics' Institute, in San Francisco, Mr. H. F. Stiver had on exhibition specimens of 500 varieties of wood, indigenous to both coasts of the Pacific. He has been twelve years making the collection.....The sugar crop of Louisiana, for the season of 1876-77 was 126,331 hogsheads, weighing 190,672,570, pounds. The molasses yield was 12,024,108 gallons; and the rice crop (the largest ever produced in the State) 186,826 barrels, or 50,669,980 pounds.....Another product has recently been developed near Marquette, Mich., (Lake Superior), a species of slate known as Novaculite, from which bones are made. The deposit is within about three miles of Marquette, and promises to be very valuable.....There are now produced in California and Nevada about 200 tons of borax per month, worth in San Francisco 8½ cents per pound, It is largely used in the manufacture of glass, and is also employed in the manufacture of enamels, glazings for earthenware, etc.....There were shipped from Philadelphia during one week, recently, 1,400 sides of hemlock and oak tanned sole leather, for Liverpool and Antwerp, valued at $11,952. During the same week there was shipped, from the same port, a cargo of 924 hogsheads of lard, valued at 86,000.

INDUSTRIAL NOTES.

—American stoves, of Philadelphia manufacture, are sold in Japan, Chili, Germany, etc.

Three-fourths of all the goat-skins imported into this country are consumed in Philadelphia.

—The Keystone Bridge Company, of Pittsburgh, have been awarded the contract for one mile of the iron work of Gilbert's Elevated Railway. Additional contracts are expected by the company.

—Screw-making machines are now being manufactured at the Cambria Iron Works, at Johnstown, Pa., and if they prove a success it is proposed to erect buildings and establish works of sufficient capacity to turn out 10,000 gross of screws a day.

The Williamsport (Pa.) Rubber Factory, which is the only establishment of the only kind in this State, and which at the time of the combination of the Association was the only rubber shoe company in the United States outside of the association, is now giving employment to 200 hands.

Arrangements have just been completed for a monthly line of steamers between Philadelphia and the Mediterranean ports. The first steamer, it is understood, will leave Malaga, taking in Denia and other small ports on the way, for Philadelphia some time this month.—*Trade Journal.*

Metcalf, Paul & Co., of the Verona Tool Works, Pittsburgh, Pa., are very busy manufacturing their line of special railroad track tools, nut locks, etc, and find the demand for them increasing steadily. They have been shipping track supplies to Europe, and meet a ready sale for them in competition with similar goods of Sheffield make. They have recently received an order from Port Natal, South Africa.

Messrs. Riehle Bros., of Philadelphia, are now building a lubricant testing machine, of their own design, for the American Gaslight Company; also a new form of spring tester. We hope to give illustrations of both these machines in due time.

Messrs. Robert Atchison & Co., who have the only establishment for the exclusive production of perforated sheet metal in the country, report their trade better than it has been before for three years, with a heavy demand from the Southern States.

A new industrial establishment has just been started in Chicago under corporate title of the French Kid Leather Manufacturing Company of Chicago. The incorporators are Louis Steinitz, F. Petrowsky and I. Salinger, and the capital stock is $25,000.

The Chicago Axle and Forge Company have applied for license of incorporation, with a capital stock of $60,000. The incorporators are Henry Childs, H. A. Gardner and A. T. Ewing, and the object of the company is the manufacture and sale of all kinds of forged iron.

Evans, Day & Co., oyster and fruit packers of Greenwood, Ind., and Baltimore, last year packed 4,000,000 cans of oysters, consuming 600,000 bushels, and during the season just closed have put up 1,300,000 cans of tomatoes and 300,000 cans of corn. They manufacture their own cans, and during the past year have consumed 20,000 boxes of tin plate.

The Benicia Tannery, E. P. Danforth proprietor, the representative institution of the tanning industry in California, occupies two acres of ground, turns out 300 hides monthly, doing an annual buiness of $200,000, and employs 40 to 50 hands It turns out 18 different kinds of leather. The works are to be enlarged for the next season's business.

The product of the Huron Bay Slate and Iron Mining Company will reach, the present year, 5,000 squares, worth at the quarry $30,000. The company is furnishing the slate for the roof of the new State Capitol of Iowa, and also a contract to furnish the slate for the Nebraska State House, at Lincoln, and expects to furnish the material for roof in the new Post Office building in Chicago.

A large quantity of the metal for cartridge shells for the Turks and Russians is made at Wolcottville, Conn., and the brass mill there is running night and day, making the general business of the town very good.

A company has been recently formed in New York to manufacture of glass veneer and decorations on glass. Plate glass is painted on the back and then glued to the wood or other material it covers or adorns. They are said to make an excellent imitation of various wood, such as French walnut, gray maple, rosewood, mahogany, bird's eye maple, satinwood, etc. Great success is predicted for the industry. The inventor is a Mr. Budd, who has had a pianoforte in use for the past two years, covered with glass veneer, during which time it has been removed thre times without breakage or even a scratch.

The American Optical Co.'s works at Southbridge, Mass., are driven to their fullest capacity. Additional hands are constantly being added, and all are working over-time. In the month of September 32,340 pairs of spectacles and eye-glasses were sent off by mail and express.

One of the model boot and shoe establishments in Massachusetts is that of Charles H. Tilton, in the town of Ashland. He employs 300 hands, and turns out 100 cases of boots and shoes per day; requiring the consumption of 500 sides of of kips and wax leather, and 225 sides of sole leather every working day in the year. No less than fourteen different kinds of labor-saving machines are in constant use in the establishment. A box and last factory is connected with the institution that furnish all the cases and last used.

—Hotchkiss & Gaylord, Cleveland, Ohio, manufacturers of machine, bridge, track, plow and elevator bolts, etc., have just received heavy orders from Canada, for bolts for railroad bridges. On an average they manufacture from 20,000 to 25,000 bolts a day.

—The Clinton Bridge Company, of Clinton, Iowa, have now under way in their shops, or in process of erection, 23 combination and 8 iron bridges, aggregating about 3,700 lineal feet. They have just contracted for 300,000 feet of bridge timber in Wisconsin, which they will need to finish up the contracts they now have on hand.

EDITORIAL CORRESPONDENCE.

Economy in Combustion.—Erratum.

OFFICE OF U. S. AUTOMATIC STOKER CO.,
No. 2 Chestnut St., Phila., Nov. 13, 1877.

EDS. POLYTECHNIC REVIEW:

Observing in the article on "Economy in Combustion," published in your issue of Nov. 3d, an error or misprint, I would ask you to make the following correction: Instead of "a primary saving of about 20 per cent. in weight, and equal increase in steaming capacity, and an additional saving in cost of slack* over large coal of about 50 per cent.," it should read: "A saving in cost of fuel and gain in steam of 20 to 30 per cent., is the almost invariable experience."

Respectfully,

ISAAC COLLINS, Secretary.

*Stock in article.

SELECTED LIST OF U. S. PATENTS.

Number of patents issued October 2, 1877., 184. Reissues, 5. Designs, 7. Trade-marks, 15. Labels, 1.

195,692. HAND DRILL. Wales Aldrich, Dayton, Ohio.

The drill may be fed by hand or automatically through gearing connected with a worm on the shaft of the fly-wheel, which includes a wheel capable of being held in or out of grer as desired, by means of a lever and spring.

195,699. CLAMP PIECES FOR INSERTABLE SAW TEETH. William Burger, Pittsburgh, Pa.

The tooth is secured in place in the plate by a binding piece, one end of which is pivoted in a seat in front of the edge of the tooth, against which it acts, and the other end formed to act as an eccentric on the face edge of the tooth. The back edge of the tooth is grooved and provided with an indentation, which engages with a corresponding projection on the edge of the plate, and locks the tooth against displacement.

175,731. DIES FOR DRAWING METAL TUBES. S. P. M. Tasker, Philadelphia, Pa. The die is divided and hinged to permit the introduction of the tongs, and is slotted, so that the tongs may be drawn back carrying the skelp. The lower jaw of the tongs fits over an eccentrically pivoted lug on the carrier, which turns on its pivot after turning from the bed-plate, thus releasing the tongs. The carrier is provided with a follower-die, which fills the slot in the main die after the passage of the tongs.

195,767. STOPPING MECHANISM FOR LOOMS. John Megson, South Adams, Mass.

The protector rod is provided with an auxiliary finger, adapted to clear the weft-fork of thread on the back stroke of the lug, should such thread have been left by the shuttle after the bobbin has become empty, or if the thread has become entangled on the fork; the finger breaks the thread, and thus allows the fork to act regularly on the forward stroke of the lug. The action of the shuttle on the swell fingers tilts the fork-clearer down out of the way of the weft on the beat up.

195,769. TOOL-POSTS FOR LATHES. Robert Nesham, Mount Washington, Pa.

The post screws into a nut which tranes in a dove-tail slot on the top of the rest, and may be adjusted as to height by turning said nut. The slotted clamp-bolt passes down through said post, and its head is held by a plate which travels in a T slot in the rest.

195,781. WALL PUMPS. Robert White, Brooklyn, N. Y.

The frame of the pump is supplied with a hinge-strap, by which the cylinder is clamped in a vertical position, permitting its ready removal. The pump handle is pivoted to a swivel-bracket, the lower end whereof is fitted to move in a circumferential groove made in the upper end of the pump barrel, below the cylinder-head, so that said head may be unscrewed without displacing the bracket.

195,800. COMPRESSED AIR WATER ELEVATORS.

Highly compressed air is forced into a pump, while in operation, to prevent shocks, the stroke being measureably regulated by the influx of air. The pressure of air is slightly in excess of that of the water in the pump.

195,833. APPARATUS FOR EXCAVATING DITCHES. W. H. Minter, London, Ohio.

This is a very simple apparatus, designed for the ready clearing out of old ditches. It consists of a platform extending across the ditch, and a slide-board hinged to one edge of said platform and extending down to the bottom of the ditch. A common scraper is employed with a system of pulleys, whereby a horse traversing back and forth above the bank of the ditch is caused alternately to draw the scraper up the slideboard to the platform, and the coupling-hook down again into the ditch—a boy to manage the horse and a man or boy to remove the loaded scraper and return it empty to the ditch. The whole apparatus is inexpensive. It is advanced along the ditch by simply drawing the platform forward, and resetting the anchors from time to time.

Patents issued Oct. 9, 1877, 189; Reissues, 7; Designs, 4; Trade-Marks, 7; Labels, 5.

195,883. SETTING OFF MECHANISM. J. P. Buzzell, Clinton, Mass.

The bobbin supporter is provided with two faces, of which the front is made higher than the rear one. The faces touch the bobbin or spool at two points, when the said bobbin or spool is not revolving, said points being on opposite sides of the spool head, and less than a semicircle apart. The edges of the two faces act as detents to prevent rotation. The spool frames are slotted for the reception of the axle of the bobbin, when an axle is used. The function of the axle is to prevent any forward motion of the bobbin from the draft of the yarn. The frames have also rods arranged in front of the spools. A weight is suspended from the yarn between the bobbin and rod When the tension of the yarn draws up the weight the spool rocks on to the front face, which allows the spool to revolve and gives off the yarn.

195,884. COTTON-BATTING-FOLDING MACHINE. B. Catlow, Cincinnati, Ohio.

The web of cotton is fed forward and folded threefold by means of the endless belts or bands, assisted by rotatory disks; after which it is wound upon rotating spindles, and as soon as sufficient material has been coiled thereon, said web is severed by the momentary stoppage of feeding-rolls. After the web is torn off or parted, the spindles are retracted from the coiled batting, which is then delivered from the machine, ready for inclosing in wrappers.

195,887. RING SPINNING FRAME. Geo. Draper, Hopedale, Mass.

The speed of the spindles with relation to that of the front rolls, also the speed of the spindles and back or other rolls is varied in relation to that of the front rolls, the speed of the latter being constant in either case. The object of the former method is to regulate the twist of the yarn and the object of the latter is to regulate both size and twist.

The frames may make the warp or filling wind. When the warp wind is being made the variation or decrease in speed by either method occurs between the commencement and completion of the winding of the bobbin; and in case the filling wind is being made, said variation or increase in speed occurs at each rise or fall of the ring rail, or as the yarn is wound from the larger to the smaller diameter of the yarn load.

195,890. LUBRICATING COMPOUND. Bridget French, Rochester, N. Y.

From one to six ounces of plumbago mixed with six ounces resin, one of tar, one of Glauber salts, three of tallon, one gallon of petroleum.

195,975. FEED WATER HEATERS. Geo. H. Borroughs, Princeton, N. J.

When the water in a lower chamber falls below a fixed point, the weight of a float turns the steam valve, and steam from the lower will pass into the upper chamber, and equalize the pressure in both. The weight of the water will open the valve between the chambers. Water from a tank will rush in and fill both chambers. The safety alarm is ordinarily filled with water moderately warmed. Should any stoppage of the pump occur, and the water fall as low as the top of the pipe leading to the heater, steam will enter through the small orifice, take the place of the water in the alarm, open a valve and blow a whistle.

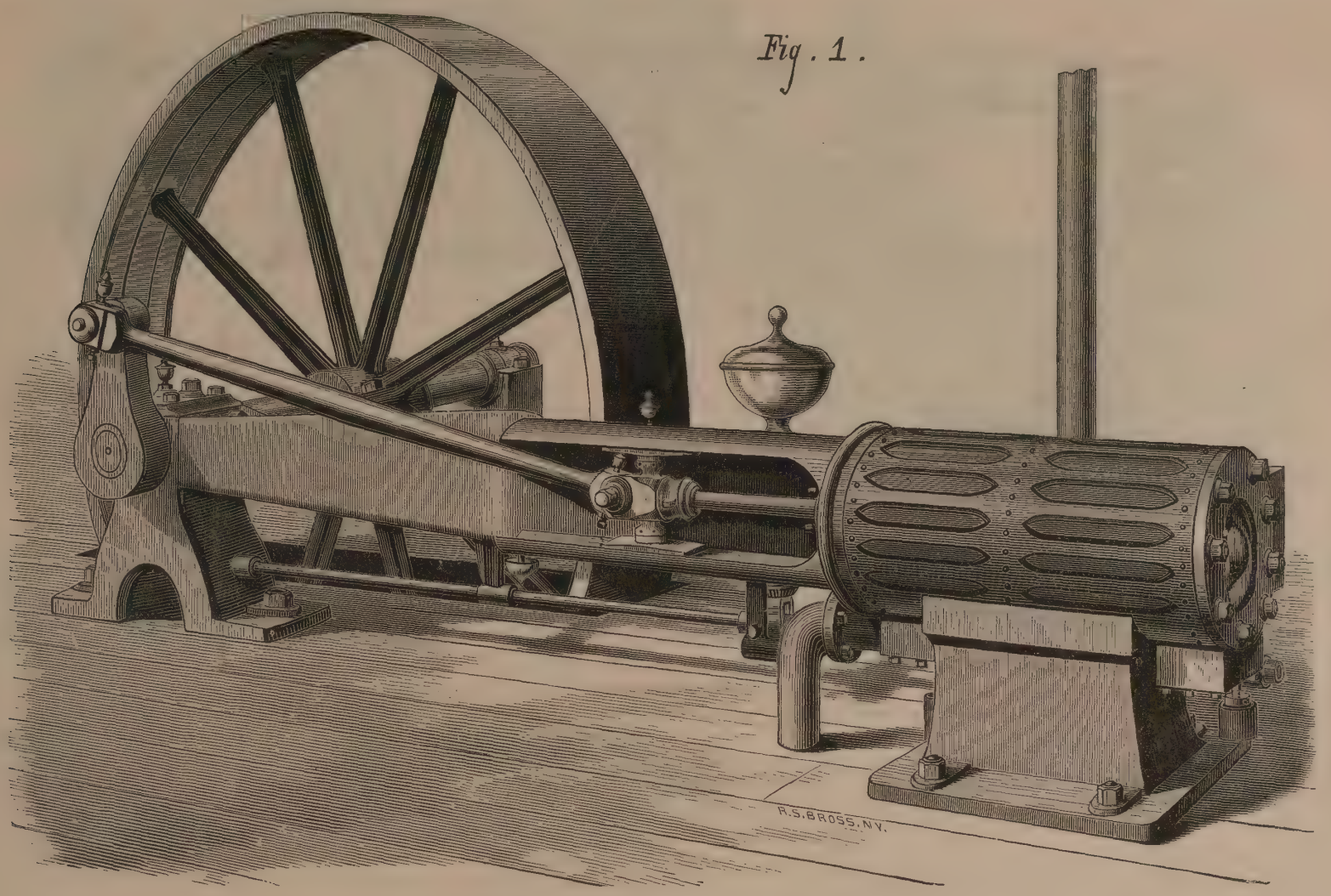
THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, DECEMBER 1, 1877. No. 22.

Fig. 1.



C. H. BROWN & CO.'S AUTOMATIC CUT-OFF ENGINE.*

We present, in the accompanying illustrations, an important form of the modern stationary engine. In this engine, all the parts are readily accessible, simple in construction, and of the best material, while for excellence of workmanship, both in fit and finish, nothing is hazarded in stating that it certainly has no superior, either in this or any other country.

It is sometimes asked, "what is the use of such superlative finish, so long as the fitting is perfect?" The finish of an engine is intimately bound up with its durability and performance, because an engineer is always influenced by the apparent quality of the machine under his care. For example, the mechanical mind is not shocked at using a wrench that does not exactly fit, providing it is applied to a rough forged nut; to apply such a wrench, however, to a finely finished nut of accurate size, would outrage his sense of mechanical propriety. So likewise, a beautifully finished engine with improperly adjusted keys or brasses, or steam-leaks in any of its working parts or joints, is a glaring and perpetual reproach to the engineer; hence, the finish largely influences his taking proper or extra care of the engine, thus keeping its economy (as well as its durability) up to its maximum.

The details of the construction of the Brown engine are as follows:—The arrangement and design of the frame, crosshead and pillow block are shown in Fig. 1, and require no comment, save that the crosshead guides are adjustable to take up the wear.

The steam and exhaust valves are plain slide valves, and are operated independent of each other; they are constructed so as to ensure a large area of opening in proportion to the amount of movement, and give free ingress and egress to the steam, and this it is, which together with the quickness of valve movement, leaves the sharp admission corner, and the freedom of exhaust, shown in the indicator cards taken from this engine. The valve seats are also independent, and the part over which the valve travels is raised, so that to true up the seats they may be taken off, and either filed or planed in a little time, the operation making no difference to the hight of valve spindle from the seating.

The valve and governor gear is shown in Fig. 2, in which the shaft *A* is revolved by the gear wheels shown upon the main shaft, and in turn, by means of bevel gearing, drives the governor. It then, through the medium of the friction device or coupling, *C* revolves the shaft *B* upon which are the eccentrics *D*, the ends of the straps of which are connected to the horizontal arms *E*, and the ends of the latter extend into the square slot provided in the slide spindle, and to the catch of the tongue.

As the shaft *B* revolves, the end of the arms, *F* will reciprocate, vertically, in the square slot. The valve stem is attached to the guide *F*, and in the slot shown in the latter, is the tongue *G* pivoted by the pin shown in the guide. The upper end of this tongue has a projecting catch upon it, beneath which stands the end of the arm *E*. Now the induction valve is closed when at the bottom of its travel, and the weight of the valve and stem and the steam pressure, acting on the area of the valve spindle, serve at all times to keep the valve at the bottom of its travel, unless lifted by the valve gear, so as to admit steam.

The manner of lifting the valve for the admission of steam is as follows:—The end of the arm *E* lifts the valve, and holds it up (and therefore open) so long as the tongue is not tripped; the instant, however, the tongue is tripped the valve closes; this movement, though so instantaneous, being rendered noiseless by means of the air cushion dashpot.

It is evident, then, that the whole period of admission is governed by the length of time that elapses between the opening of the valve and the tripping of the tongue.

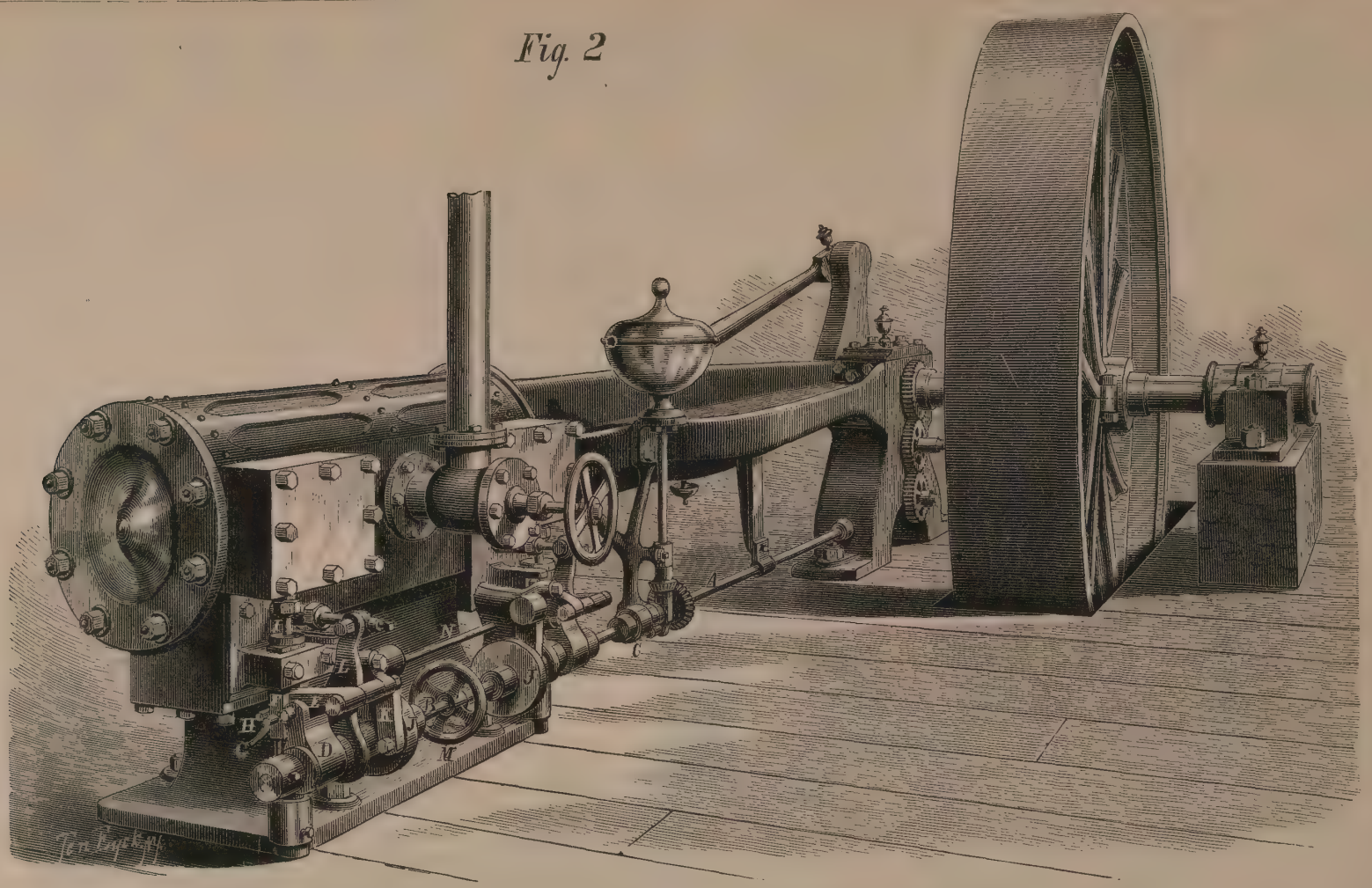
Now the position of the eccentric having been determined and fixed, admission will always take place at the same point of the stroke, and hence the supply of steam to the piston will always be equal and constant, at the commencement of the stroke, and therefore the cutting off of the steam supply is coincident with the tripping of the tongue.

The manner in which this tripping is made to coincide with the requirements of the load upon the engine, is as follows:—

The governor spindle is attached to the end of an arm which is fast upon the rod *N*, and upon this rod, and immediately behind the induction valve spindle guide *F* is an arm standing vertically, and carrying the horizontal pin *H*. Now the tongue which at one end acts as a catch to the eccentric arm at the other end, protrudes from the back of the slide spindle guide, and stands directly beneath the pin *H*, so that when the arm *E* lifts (through the tongue catch) the induction valve, the latter remains open until the tail of the catch *G* meets with the pin *H*, when the tongue is tripped and the valve closes again. The action of the governor, by controlling the position of the pin *H*, determines the point of cut-off, and thus, while any change in the amount of the load upon the engine is instantly felt and shown by the increased speed of the governor, the latter simultaneously changes the point of cut-off, giving to the engine more or less steam, as the load may require.

*Manufactured only by C. H. Brown & Co., Fitchburg, Mass.

Fig. 2



It is evident that in engines such as this, in which steam may be admitted during any period of the stroke (from the commencement to three quarters of it) according to the load, the governor has a very important duty to perform, since it determines the horse-power of the engine (within certain limits), and that, if under a very light load, anything happens to the governor's mechanism, the sudden increase in the period of admission and its excess in proportion to the load, would cause the engine to accelerate in speed to such a degree as to endanger its safety. To avoid this danger, which is common to automatic cut-off engines, the governor is entirely encased in a cast-iron envelope, and is driven by gears (instead of belting), thereby receiving a positive motion. All pivoted parts are of steel and are hardened. The rods are of steel, and the slide spindles are of brass, so finely fitted to the stuffing boxes that they have been known to run for several months, steam tight, without any packing whatever. Both at the Centennial and at the American Institute, this engine received medals of the highest order; the indicator cards taken at both places showing extraordinary perfection in the use of the steam.

J. ROSE.

EBURINE.*

M. Latry recently presented to the *Societe d'encouragement* the results of his experiments in the manufacture of *bois durci.* Under the name of *eburine* he showed a product obtained by the employment of powdered ivory or bone, with or without the addition of agglutinative substances.

The fabrication of *bois durci* consists, as it is said, in introducing into moulds of steel, bronze, or malleable iron, the saw-dust of *pallissandre* wood mixed with albumen or more simply with beef blood. The powdered mass resulting from this mixture is strongly compressed in moulds under the hydraulic press, and at the same time heated to a regulated temperature sufficient to bring the mass to an almost plastic state, and then forcing it into the recesses of the mould so that it possesses on cooling all the finish of the model.

Since 1864 the inventive and eminent industrial skill of M. Latry has introduced notable ameliorations in this fabrication.

Three hydraulic presses worked by a steam engine give the necessary pressure; the heating of the moulds by gas, which entailed and expenditure of 15,000 francs per year, has been replaced by a new system consisting in circulating air, heated to a a sufficiently elevated temperature, in the plates used to heat the moulds. The appreciation of the proper temperature was formerly attained by the workman passing his moistened finger lightly over the plate, but is now more accurately determined by the employment of fusible alloys. A shop is supplied with filing, planing and boring machines of sufficient strength, not only to repair but to make all the tools of the establishment; here also are made emery wheels of coarse grain, which are indispensable for the mending and the polishing of the pieces of *bois durci*, for the material of this is so tough that it rapidly takes the edge off of ordinary tools.

M. Latry has since a long time been endeavoring to add artistic perfection to his work, and has succeeded by the admixture of various coloring materials in making applications of his product, from which its black color heretofore precluded its use.

After many trials M. Latry chose a material which, like the sawdust, is a residue of manufacture, that is, the produce and débris (filings &c.), of ivory and of bone, and on their employment obtained the best results.

Objects manufactured from these materials when they are still in moulds crack from rapid alteration or excess of heat. It required numerous trials to establish the proper temperature to which the material durst be heated, and the proper time to cool the articles by placing them in a current of air.

The mineral matter of the bone, phosphate and carbonate of lime is thoroughly cemented together by organic material. Hence the heating of this material is a very delicate operation: care must be taken that the temperature be not so elevated as to produce the decomposition of the organic matter, and that the gases generated in the mass do not render it porous: for the appreciation of the proper temperature M. Latry, as already stated, employes pastilles of fusible alloys.

The material thus treated is slightly grey in color, and it is often preferable to give a distinct color by the admixture of various pigments, all of which should not be effected by the temperature necessary for the fabrication of the article. In this way all colors and the most beautiful effects can be obtained. For objects that are to be of a light color it is necessary to use gum arabic or gum tragacanth as agglutinative materials instead of the beef blood.

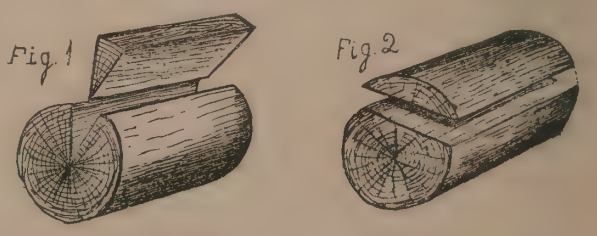
When M. Latry made these presentations, the product which he obtained possessed such great hardness as to be forced with the greatest difficulty into the crevices of the mould, and could scarcely be worked on the lathe or with the file; this rendered the cost of workmanship so great that it was more economical to work iron than the eburine. This difficulty has been overcome by using the eburine with the delicate design and color, on the surface, and forming the rest of the mass of *bois durci*; these two materials are formed in the same mould, and so perfectly joined as to present the appearance of a single material.

Since by the admixture of various materials M. Latry has succeeded in giving elasticity to the mass, he has overcome the liability of cracking and has furnished a material as easily fashioned as the *bois durci*; he forms his material at will into blocks or into moulds. The grain of the eburine is so fine that by the admixture of the proper coloring matters, he can imitate such stones as jasper, malachite, lapis lazuli; or by sprinkling powdered colors in the moulds, he makes imitations of mosaics, cameos of various tints, bouquets of flowers, &c. M. Latry has manufactured pieces of large dimensions, of various colors, and of artistic finish; in utilizing a residue of manufacture which heretofore had no remunerative employment, he has given to the industries and to commence a product susceptible of numerous applications.

*Translated for the POLYTECHNIC REVIEW from *Le Technologiste*, 1877, 221.

WHY THE BACK AND BELLY OF A VIOLIN ARE FORMED OF TWO PARTS EACH.

In a correspondence addressed to the *Scientific American*, Mr. E. P. Wheeler, of Rockland, Mass., states that it is his opinion that the two-fold division of the back and belly of a violin is not made in order to give the instrument better tone, as many makers believe, but because it affords a greater economy of wood than if made in one. Thus, Fig. 1 represents the mode of cutting the log in order to get the back in two pieces—the piece separated from the log being afterwards divided. Fig. 2 shows the log split so as to obtain a whole back or belly. It will thus be seen that by dividing the log as in Fig. 2, we could get four backs at the most; while by the method adopted in Fig. 1 the number is greatly increased and but little is wasted, a great advantage where a fine log is to be cut. The two pieces are glued together with the edges that were next to the bark inwards; the under side is planed flat, and the upper or outside is planed down somewhat like the roof of a house, that is the highest in the centre and sloping gradually towards the edges. The form is then scooped or worked out to the taste of the artist, in doing which a pair of double caliper compasses are used in order to maintain a due thickness in the respective parts. In Germany and France, where the manufacture of cheap violins is carried on very extensively, the backs and bellies are formed by steaming and then compressing then in hot iron moulds. This is only done for very cheap and toy violins, it being impossible for an instrument with the back and belly so formed to produce a good tone.



THE "NEW HOME" SEWING MACHINE.

Referring to the great perfection to which the mechanic arts have been brought by man's ingenuity and industry, we often hear remarks intended to convey the idea that now the top of the ladder has been reached, and that there remains no longer any considerable field for the exercise of inventive genius; and it has appeared to many, even of our best and most fertile inventors, any time during the last decade, that the sewing machine, particularly, had about reached its limit of perfection; that little possibility remained for its *further* improvement. So far, however, has been such a

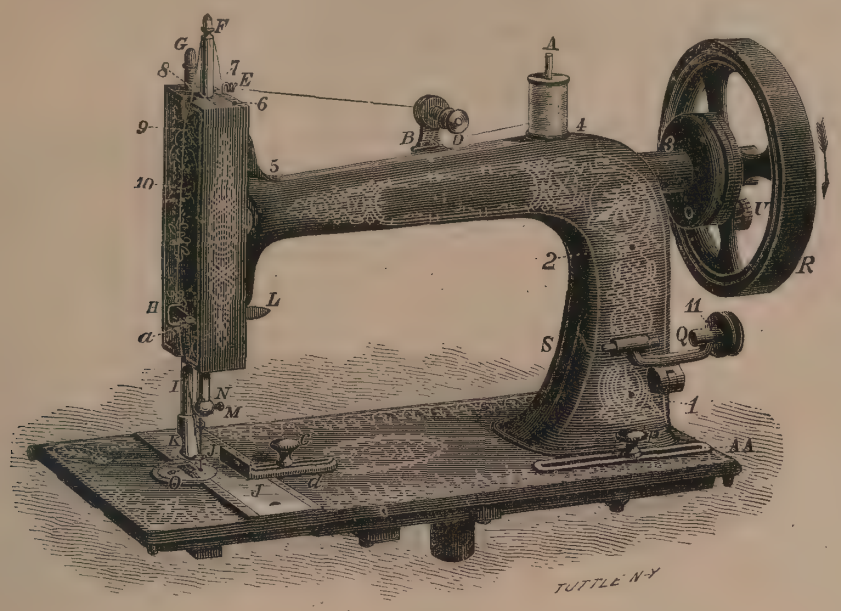


Fig. 1.

notion from the truth that if we look back but ten years in the history of this great saviour of human labor and patience, we will see the sewing machine as an example of a far less amount of ingenuity than has since that time been expended upon it, and conclude that, as it stands to-day in its multitudinous forms, it differs far more from the sewing machine of ten years ago than did the latter in its then best and most perfect form from the original machine of Howe. This is equally true, too, if applied to the productions of any single representative company; and, with most of them there is scarcely a week passes without the appearance of some more of less valuable improvement. Most of the companies have, and control, some fundamental device or combination, which is the characteristic feature of their machine, and which is retained throughout, and whose usefulness is enlarged from time to time, as the almost constant stream of improvement deposits its share with each of them; most of these, too, have their especial fields of usefulness, as one is best adapted to sewing leather, another the various kinds of heavy clothing, and others for the lighter fabrics while some are best adapted for the hard wear and tear of manufacturer's general use.

The Home machine was originally, what its name implies, a family machine, and to the improvement of it, as such, has been the constant aim of its proprietors, Messrs. Johnson, Clark & Co. 30 Union Square, N. Y. Every one interested in this elegant, branch of mechanics—and who at this day is not?—will, upon the most cursory examination, become convinced that, in the general march of improvement, the proprietors of the Home machine have kept pace with the most successful of their competitors, and that in more than one essential feature they are in the vanguard of improvement.

Like most of the principal sewing machines of the day, while retaining their original fundamental design, the Home machine has, within a comparatively short time, been practically remodelled, and as quite lately improved, is presented to the public as a representative family machine, and, at the same time, eminently adapted to the lighter manufacturing.

It will be patent to any one that a sewing machine cannot be given the might and strength necessary to its successful use in the factory, upon the heaviest and most refractory material, without detracting from its value for an adaptability to family work; and this view has been so closely adhered to in the Home machine as to leave, in its latest improved form, nothing to be desired for domestic purposes.

Fig. 1 is a perspective view and Fig. 2 a view of the under side of the machine, and the first general feature of it which will strike the observer is that the frame incloses a more than ordinarily large space for the passage or collection of the material operated upon. It will not be much to say that a larger volume of goods may be passed through under the arm of this machine than is possible with any other family machine now made, and operators well understand the value of this, and the annoyance and difficulty attending the manufacture of large skirts, dresses, and other bulky articles, in a machine having a small space under the arm.

The next general feature is that the mechanism is almost entirely inclosed by the frame, leaving a generally smooth and unobstructed contour; there being no turns, corners, or points, for the operator to come in contact with.

Among the many improvements lately made upon it are the following:

Appreciating the great importance of durability in a sewing machine, the working parts are made of the very best material, and all rubbing surfaces not made of cast-iron, whether pivots, points or sliding parts, are case-hardened, and in order that the perfection of its working as newly made may continue indefinitely, every point in which lost motion could occur from wear, is made adjustable, as, for instance: The eyes on the end, of the link *Y*, Fig. 2 which transmits the motion of the disc *x* on the lower end of the vertical shaft inclosed in the vertical part of the arm of the machine, and not shown, is slotted and may be brought together at any time by a moment's use of the screw driver upon the small screws which are set in the lugs. Even the needle bar itself may be kept in the same perfect condition by setting up a small screw near the top of that part of the arm in which the middle bar slides—not shown—which closes up the collar or bush carrying the top of the bar, and, without referring to all the parts thus provided, it may be said no part of the machine can become loose, if these matters are attended to once in a year or two. It is probably owing to these provisions that the machine runs at all times almost noiselessly.

It is exceedingly simple in construction, and is made up of very few parts, all of which goes toward simplifying the preparatory education of those who are to use it; in fact, to any person of ordinary intelligence, little, if any instruction is required to enable them to operate it with the best results.

It is well entitled to the cognomen "light-running," given it by its manufacturer, and the fewness of parts and simplicity of construction will fully account for this. The device by which the reciprocatory motion of the shuttle is accomplished is an admirable one, bringing the shuttle to rest gradually at the ends of its travel, just as the piston of a steam engine is brought to rest as the crank approaches the centre. The shuttle-carrier, *V*, is in the form of a lever of the first order, whose arms are in about the proportion of two to one, and make an angle with each other of about 135°. The link, *Y*, connects the short arm to the crank-pin in such direction as to give exactly the same motion to the lever arm for each half-revolution; and of course the shuttle end of the lever has a precisely similar motion, except that it is of double the extent. This whole arrangement is an admirable piece of mechanism, and the adjustability of the pivot bearings in it renders it practically perfect.

The feed mechanism is a no less marked and advantageous feature in this machine. In Fig. 1, *AA*, is a dial or index, in form of a slot, in the bed-plate, in which the milled head-screw is secured at any point desired. The slight elevation surrounding this slot is divided off on one side in regular divisions, each indicating the length of stitch made, and on the other side the number of stitches to the inch, corresponding to these positions for the screw, are plainly stamped; so that the operator can, in a moment, set the feed to make the stitch of any desired length, without previous trial. The set-screw actuates the slide, *Z*, Fig. 2, the end of which carries the fulcrum of the feed-lever, *W*,

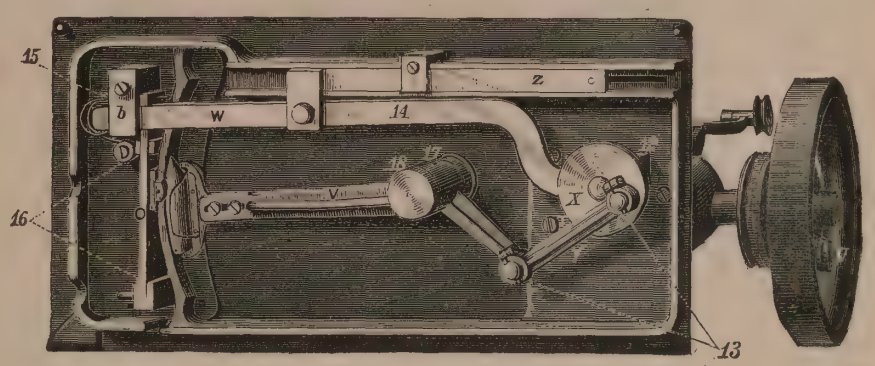


Fig. 2.

changing the position of this fulcrum to the same extent that the set-screw itself is moved, and thus by varying the relative lengths of the two arms of the feed-lever and thereby the length of stitch. This feed motion is very positive and powerful, and is as precise in its operation whether feeding light or heavy goods or crossing seams and excessive variations in thickness of work.

Perhaps one of the most felicitous improvements lately made in this machine is that of providing for the winding of the bobbins without keeping in operation the working parts of the machine proper. This dispenses with the labor of running the whole machine, and permits of any work in hand at the time that the bobbin requires to be refilled, being left in place and undisturbed until a newly-filled bobbin is placed in the shuttle. The manner in which this is accomplished is very simple, and is momentarily effected. The fly-wheel, *R*, and pully run loose upon the shaft, but may be articulated with it at will. By pulling out for a short distance the thumb-screw, *U*, and turning it partly round, the pully and balance-wheel are disconnected from the driving-shaft, when the bobbin may be wound in the usual way upon the winder, *Q*, without bringing into motion any other part of the machine; and to restore the connection again, the thumb-screw has only to be turned round until by a spring it is thrown into a notch as the treadle is again started in operation. This in no wise interferes with the timing of the various parts of the machine; and in fact it is so constructed throughout that it is impossible for it to get out of time unless by the breaking of one or more of the parts.

The tension is practically automatic, both for the upper and under threads, and when adjusted properly to start with, will be found to make the stitch correctly, with locking perfected within the body of the goods, for all work within the range of ordinary family sewing. In connection with both tensions, the friction upon the thread is accomplished by springs of such a character as to very exactly compensate for the variations in thickness of goods, length of stitch, and thickness of thread.

In connection with this is automatic arrangement of the tension, a self-acting take-up, by the aid of which the finest or coarsest thread, cotton, linen or silk, may be used indifferently without the slightest danger of breaking threads or chafing them on their way from the spool or bobbin to the goods.

An exceedingly important improvement is the new open-head cylinder shuttle. Not only is it one of the most serious annoyances to sewing-machine operators to be obliged to rewind the shuttle bobbins so frequently, but the number of openings through which the thread requires to be passed—as troublesome, some of them, as the threading of a needle—and the difficulty in regulating the tension, with the shuttle as ordinarily made, constitutes no small obstacle to its effective and rapid use.

In nearly all other shuttles the bobbin rotates upon centre-points at either end, and a portion of each end of the shuttle is necessarily occupied by the bearings for these points. In the New Home shuttle, however, the bobbin is held in place by turning a shallow neck just back of the centre-point on one end, in which a suitable spring-catch is made to fall upon inserting the bobbin, and dispensing entirely with the point on the other end. In this way one bobbin head may extend out flush with the extremity of the shuttle, and thus make use of the distance so gained for the reception of the thread; and the rotation of the bobbin at that end is done upon its own periphery

the friction of which constitutes a small part of the required tension of the thread. The subsequent threading is entirely done without once having to pass the thread endwise through a hole—as in the threading of a needle—every opening through which it has to pass having a slot leading to it, so that the thread may be entered sidewise; and no explanation may be required to show that the latter is an infinitely more facile operation. The tension may at any time, and without removing the work from under the presser foot, or making any other change whatever, be regulated by the application of the screw-driver to small screw on one end of the upper surface of the shuttle, which is uncovered by partially removing the front half of the sliding-plate which covers the shuttle and its race. This improvement permits of the bobbin holding one-half more thread than the one previously used in this machine, and one-fourth more than the other largest bobbin in use, and it can be wound and placed ready for operation in a minimum of time, while the tension can be regulated as quickly and easily as with the upper thread itself.

Messrs. Johnson, Clark & Co. manufacture eight different styles of the Home machine, from the plain iron stand with one drawer, to the full case-inclosed machine; among which may be found something to suit the taste of any one, however fastidious.

J. T. HAWKINS.

SAMIAN, OR OIL TAWING,

ITS APPLICATION TO THE MANUFACTURE OF SHAMMIES.

This means a peculiar process of preparing hides of various animals (deer, sheep, calves, &c.), without the assistance of tannin or salts of alumina—giving a white or yellow leather called *wash leather* or shammy, from chamois. (The skin of this animal being the only one made use of in the 16th century for the manufacture of military breeches and other articles of clothing, which has been to a certain extent abandoned for reasons before spoken of.) (See REVIEW.)

The principal uses of this leather are for the manufacture of gloves, belts,&c., and to a small extent for polishing jewelry with "rouge," (an oxide of iron), its manufacture for the above reasons has now been greatly diminished.

The advantage of being able to use soap without damage renders it a very useful article for many household purposes, as for washing windows, etc.

I must not forget to mention that in purifying mercury it is of great service, as its pores are very close, and for that reason will not permit any foreign substances other than the metal to pass through.

The skins are put through the liming process, and afterwards scraped on the beam in the ordinary manner, care having been taken to choose the finest of each skin.

The other operations greatly resemble the manufacture of glove leather, "the only difference being that the hair is removed together with the hair side portion of the skins."

Great ductility and suppleness being necessary, the upper layer of the corium must be removed, since being very compact, it does not possess the qualities wash leather should possess, and for that reason it is entirely cut away. Another great advantage of this operation is to facilitate the absorption of the oil. When skins of goats be utilized it would be impossible to remove the hair side of skin, as the leather obtained would be so thin that it would not have any practical value.

The grain surface is removed with pumice stone. This operation is frequently called *frizzing*. The skins are now submitted to the fulling mill until they are nearly dry, after which they are placed on a table, the hair side being the first to receive the oil, (some greatly recommend the use of fish oil), which enters the pores in a very limited manner. Any animal oil will give results very satisfactory, and for that reason I cannot see the advantages of recommending any one in particular.

Its application being entirely done by hand, no great skill is necessary.

The quantity of oil of each application is governed by the amount adhering to the hand after being dipped in this substance.

The skins are now folded in 4, and are placed in a trough, which is cut obliquely out of a strong block of wood.

The hammer consequently strikes the skins at an angle of 45°, after having described an arc of a circle. After having been submitted to this beating process for several hours, they are taken out and exposed to the air for a short time, then smeared with grease as before.

By repeated operations the skins become dry and the oil is absorbed.

The workman is governed in this process by the odor produced, which, instead of being fleshy, greatly resembles that of a horse radish, when the impregnation is at a maximum.

The following is far the most difficult of any operations that we have as yet spoken of, as great experience is required.

The skins are placed in warm rooms, heated most generally by steam; the temperature must be kept constant, or nearly so. They are heaped together and covered with cloths, in order to keep the caloric, which is generated constantly if not continually exposed for a short time to the air, overheating will take place, which would be the cause of a great loss to the manufacturer. This is kept up until the skins have acquired a yellow hue.

Very little is known in regard to the real chemical changes that have taken place, but the heat is supposed to have caused a slight fermentation and consequently prevents the combination of the oil with the animal fibre. There still remains a certain quantity of grease which must be gotten rid of. This is done by placing the skins for three-quarters of an hour in a tepid solution of potash, marking 2° Beaumé.

The oil combines with the potash, and forms a soluble soap.

The price of this article in the market depends upon size, color, suppleness and ductility.

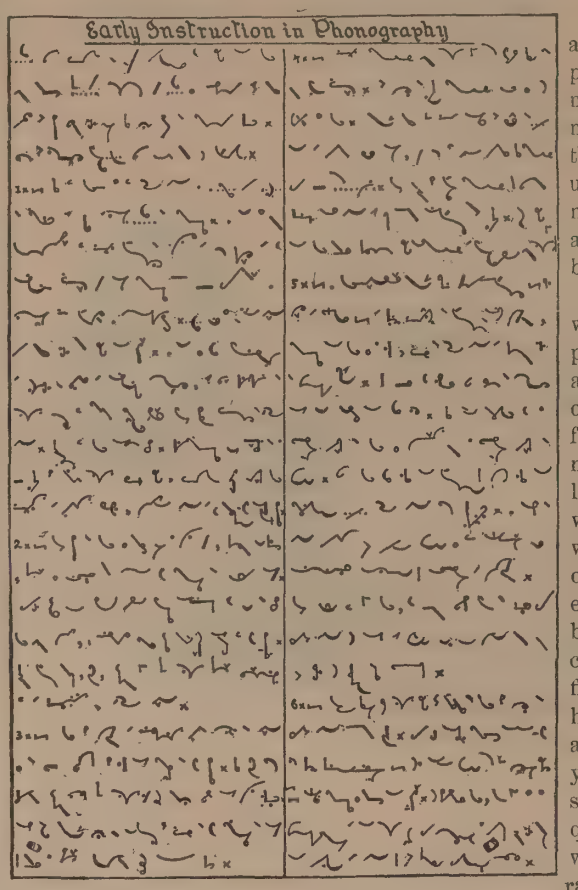
Frequently the color wished for is buff, which can easily be obtained by dipping in an infusion of oak bark, which, under these circumstances, acts as a dye.

L. S. WARE, C. E.

THERE are two valuable mercury mines in Japan; but are not at present enterprisingly worked. The cinnabar occurs as local interpolations in the sandstones of the coal measures, filling up small seams and fissures in the rock.—*Telegraphic Journal.*

EARLY INSTRUCTION IN PHONOGRAPHY.*

TRANSLATION OF ARTICLE PRINTED IN AUDATYPE, BY ROBERT PATTERSON.



Those well qualified to judge are convinced that instruction in phonography should be begun at a much earlier age than is customary, and that the best results of the study will not be attained until it is made a subject of primary education. Some of the arguments for this view will now be set forth:

1. It is with phonographic as with ordinary writing—the principles are easy of comprehension, and the difficulties mainly those of practice. The hand has to be familiarized with the accurate formation of letters and word outlines, and that instinct acquired, which only practice can give, whereby the manual act follows on the mental conception. These ends, as to common writing, are best attained by instruction in childhood. The hand is then flexible and easily trained to habits and instinctive movements, and the slight daily drill of early years, with proper supervision, suffices for the satisfactory acquirement of ordinary writing. It would be the same with phonography, in the same circumstances. Daily practice, under the guidance of a good teacher, as a part of early school instruction, would qualify children to write phonography accurately and rapidly, and at least as soon as they would learn common writing, and without obstructing other needful studies.

2. If the study of phonography is postponed until a later age, it must be undertaken when the time is engrossed by many other branches of necessary knowledge. We contend that this is no sufficient reason for its neglect, and that under all circumstances phonography should be learned; but experience proves that it is pushed aside in the competition with other studies. It would be far better, therefore, that it should be taught at an earlier time, simultaneously with, and auxiliary to, ordinary writing.

3. Phonography, as a legible and extremely rapid method of writing, is of great utility as an aid in the pursuit of other studies. It is, therefore, very desirable that it should be mastered at an early age, so as to be made use of in the later education. Instead of then being made to interfere with the acquisition of other branches of knowledge, it becomes a highly valuable assistance in their attainment.

4. Accurate pronunciation should be early taught, or otherwise it is not apt to be ever acquired. Of the means of teaching pronunciation, none is so thorough as phonography. Being based on an accurate analysis of the sounds of our language, and representing sounds only, each word as written represents its pronunciation, whether good or ill. If the pupil has a false pronunciation, it will be detected in his writing, and the true can be enforced by the teacher. So that instruction in phonography becomes at the same time instruction in pronunciation, and for this reason should be early taught.

5. The phonographic writing signs being strict geometrical forms—straight lines and curves—and demanding accuracy of formation to ensure legibility, practice in phonography is an aid to the acquisition of ordinary writing, and, it may be added, of elementary drawing. It gives that steadiness, and yet freedom, of movement in the hand indispensable in those arts. It is of common observation that a graceful writer of phonography is likely to be a graceful writer of long-hand. While phonography thus aids in forming, it also aids in preserving our ordinary writing from deterioration. The necessity of writing rapidly, to which our common long-hand is quite unequal, ends in many cases in making it ungraceful and illegible. If the young were taught phonography, that could be used for all occasions where swift writing was needed, and the long-hand need no longer be put to a strain so destructive of its character.

6. Finally, it is only through early instruction that the possibilities of phonography, as a means of swift writing, can be developed. We do not anticipate perfection in any other art demanding technical skill, say in common long-hand, or on a musical instrument, unless practice is begun in childhood. So as it respects phonography, if taught as an elementary branch, and in early youth, we may be certain that a rapidity would be attained, both in reading and writing it, of which at present we have no examples.

*We beg to acknowledge our indebtedness to the *Journal of the Franklin Institute* for the accompanying cut.

ANOTHER "FIVE DOLLAR" IDEA—HOW TO FILE A SAW.

The general practice in filing hand-saws, that of crowding the file straight down, cutting away the metal from the back of one tooth and the front of the next at the same time, is not the best practice. Crowding the file first against the fronts of the teeth and then the backs, going four times over the saw, enables an experienced hand to do better work, does not wear out half as many files, and makes no disagreeable noise.

Set the saw in the vice with the handle at the left hand, file the fronts of all the teeth on the side away from you, but not quite to a point, change ends with the saw and file the fronts of all the other teeth, then file the backs of the same teeth to a point. Change ends with the saw again, and point the first row. J. E.

MEASUREMENT OF WATER MECHANICALLY SUSPENDED IN STEAM.

BY PALAMEDE GUZZI, C. E.*

The greatest difficulty which is encountered in determining the co-efficient of evaporation of a steam generator, or the weight of vapor produced in a given time, is in measuring the water which it carries over from the boiler by mechanical action.

This problem, which has acquired a greater importance since Hirn, Leloutre and Hallauer, by their overthrow of the old theories of the steam engine, have opened the way to the true theory, is not yet completely solved.

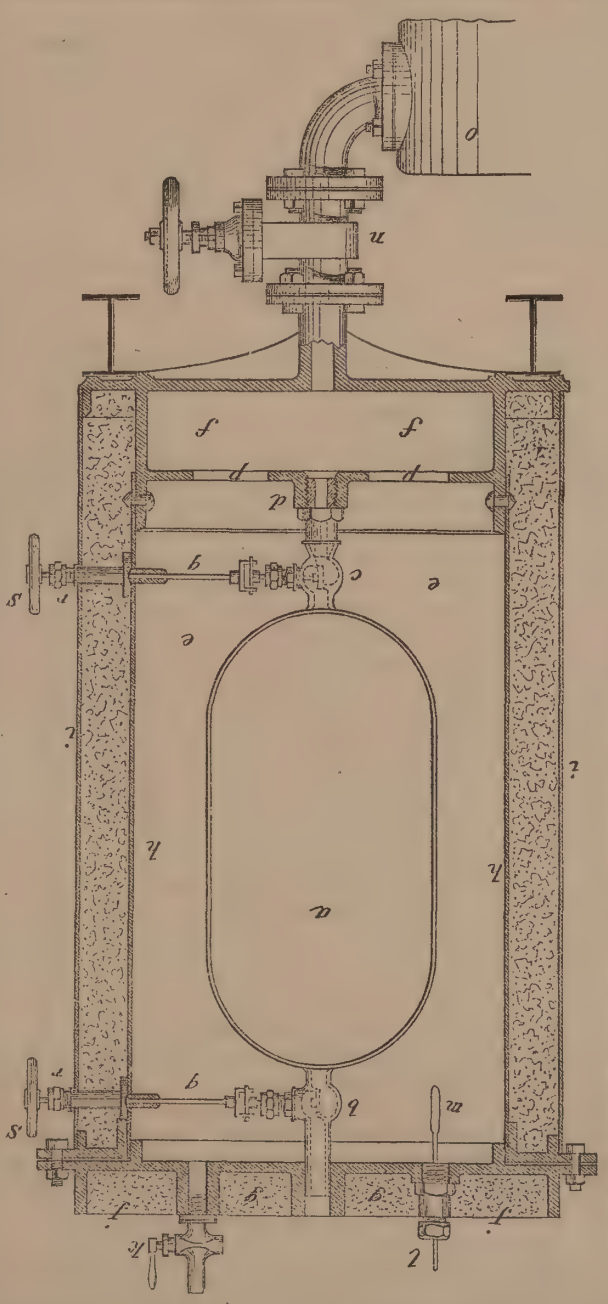
The only solution of real importance among the many which have been hitherto attempted, is the one suggested by Hirn, and followed by the distinguished experimenters of the Industrial Society of Mulhouse, and others. Even this leaves some uncertainty, so that the Mechanical Committee of that society has recently renewed its offer of a reward for a better method.

Hirn's plan consists in measuring the total heat of a given weight of steam, and comparing it with that which would be found in dry, saturated steam, as given by Regnault's formula. His apparatus consists simply of a coiled tube, surrounded by water.

But there is some indeterminate portion of the energy of the steam, which is so transformed as to be incapable of measurement. The vibrations generated by the flow of steam, in the coil, and in the surrounding water and air, as well as in the boiler itself, represent a transformation of heat into mechanical energy. A part is manifested in the form of sound, and is lost; only a small fraction of the remaining portion can reappear in a greater elevation of the temperature of the water. Moreover, during the flow of steam and its condensation in the coil, recent experiments have shown that there is a conversion of thermal into electric energy.

It is true that Regnault's experiments were made under similar conditions; but for that very reason there is a greater need of other means of experimenting for purposes of comparison or confirmation.

I have devised an apparatus, consisting mainly of a vessel which is filled with the steam of which it is desired to measure the humidity, and which is protected, as much as possible, against radiation and consequent internal condensation. Its capacity, and the weight of the vapor contained in it, being known, it is easy to ascertain the amount of dissolved or suspended water.



This recipient, marked *a* in the accompanying diagram, is made of copper, in the form of a cylinder with hemispherical ends. It has an upper valve *b*, and a lower valve *c*, which is fastened by the screw *d* to the bottom of the chamber *e*. This chamber, which serves as the envelope of the recipient *a*, is formed of the double bottom *f* and the cover *g*, which are both of cast iron, and the cylindrical sheet-iron wall *h*. The sides and top are protected by non-conducting materials enclosed in the external envelopes *i*, *j*, which are made of polished brass. The covering receives the pipe leading to the valve *b*, and contains the stop-cock *k*, as well as the stuffing-box *i*, through which passes the stem of the thermometer *m*.

The double bottom *f* is put in communication, by means of the receiving valve *m*, with the steam-dome *o*; by means of the openings *p* with the chamber *e*; and, when desired, with the interior of the recipient *a*. The valves *b* and *c* are worked by means of the hand-wheels *s* and the spindles *q*, which traverse the stuffing-boxes *r*. In order to diminish as much as possible the transmission of heat from *b* and *c* to *s*, the spindles are made hollow and pierced with holes, so as to increase the surface of contact with the steam of the envelope *e*, while the heat-conducting sections are diminished.

In experimenting, the air is driven from *e* by opening *k* and *m*; *k* is then closed, and after some time *b* and *c* are opened. After the air is driven from *a*, *b* is closed. After some seconds, when the equilibrium of pressure is established, *c* and *n* are closed; the cover *g* is lifted, and the spindles *q* being withdrawn, the recipient *a* is removed to be weighed. The total weight, less the weight of the receptacle, gives the weight of the mixture of water and steam; deducting the weight of an equal volume of dry saturated steam at the same temperature, we obtain the quantity of water dissolved in the steam.

Care is needed in determining the tare of the vessel *a*. To take account of the vapor which is condensed upon the inner walls of the vessel and adheres to them, it will be well to experiment with a generator from which no other vapor has been withdrawn, and which has not been heated for some time. Subtracting from the weight of *a*, thus filled with vapor, that of an equal volume of dry saturated vapor at the same temperature, we get the weight of the empty vessel, but internally bathed; this is the tare.

The apparatus could also be applied to the determination of the density of dry saturated vapors, under high pressures, for comparison with the results of Fairbairn and Tait,† and to find the values of *r*, in the formula of Clausius, $APu = \frac{rP}{T\frac{dP}{dT}}$ for comparison with those obtained by Regnault.

[For the cut and abridgement we are indebted to the *Journal of the Franklin Institute*.—ED.]

*Abridged from a communication to the Milan College of Engineers and Ar chitects, January 21st, 1877.

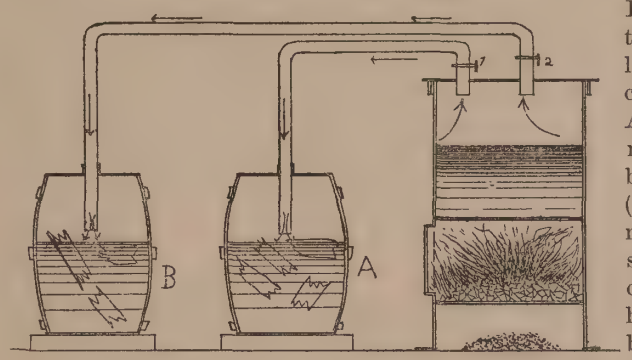
†*P. Mag.* [4], lxii, 230.

TAN BARK.

There is a special time for removing the bark from the tree, and that is when the sap is in full activity. If this fact be not observed, the quantity of tannin will be small, and if due respect is paid to it the result obtained will highly compensate.

The ordinary method of removal is to cut upon the tree two horizontal circular rings, the depth of which is equal to the thickness of the bark, and about 14 inches apart; vertical cuts are then made extending from the upper to the lower horizontal, but two to three inches from each other. The bark comes off with ease; it is then dried and tied up in bundles, to be sent to its destination.

Joseph Maitre had the excellent idea of utilizing steam. (This I had occasion to mention in the REVIEW* some weeks past, but failed to explain the advantages derived from this process.) Bark up to this date having the defect of staining the leather, this was a great commercial inconvenience. A small sketch of the apparatus before spoken of may be of interest. The cocks (1) and (2) are opened alternately. This operation is successful with bark freshly cut as well as with that having for some months past been submitted to the action of the sun.



The tannin is in no way altered, and the skins prepared by its use are whiter and heavier than any ordinary bark can produce.

After the steaming is finished the bark is dried and tied in bundles as before.

Messrs. Gagey-Segum, engineers, at Dijon, France, have improved the above machine. A description of their ideas and plans of their invention, would require here too much time and space. They made a series of calculations proving that the money saved by economy of labor compensated in a few years for the amount expended by the purchase of their apparatus.

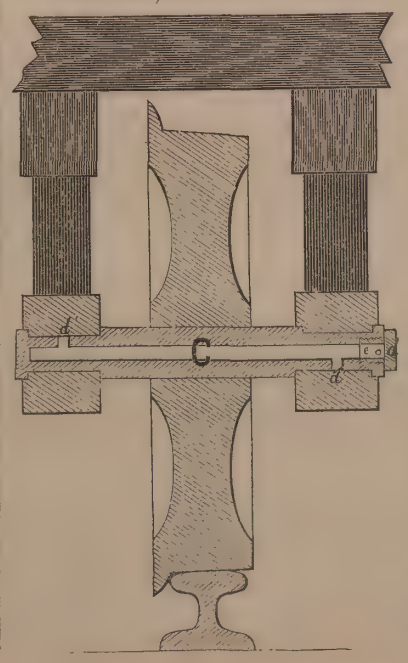
L. S. WARE, C. E.

*Leather and Tanning, p. 171 of current volume.

WILLIAMSON'S SELF-LUBRICATING AXLE.

The accompanying engraving illustrates a method of effecting the automatic lubrication of car axles by means of independent tubular axles adapted to contain the lubricating oil, and which is to be fed to the bearings by centrifugal force.

As stated, each wheel has an independent axle, having its bearings in journal-boxes arranged between standards in the usual manner. As shown in figure, *C* is the tubular axle containing the oil and having apertures *d* and *d* in opposite directions, which gives passage for the oil to the bearing surfaces. The outer end of the axle is closed by means of a screw, which has in it a small opening *o*, through which, by means of a spouted can, the oil can be introduced when the screw is slightly loosened. Since the centrifugal force governs the supply of oil to the bearings, it is evident that the supply will be greatest when most needed. The importance of a self-lubricating axle (as here understood) is so well recognized as to require no further comment. It is evident that the method herewith described is preferable to the ordinary box system in affording a larger reservoir for the lubricant, and therefore requiring less frequent attention and filling; but its special excellence consists in the way in which the oil is supplied to the bearings, both as regards the governing of the supply and the placing of the oil in the middle of the bearing to be lubricated.



O. C. W.

PROTECTING IRON FROM RUST.

ON THE PROTECTION FROM ATMOSPHERIC ACTION WHICH IS IMPARTED TO METALS BY A COATING OF CERTAIN OF THEIR OWN OXIDES, RESPECTIVELY.

A PAPER READ BEFORE THE BRITISH IRON AND STEEL INSTITUTE AT ITS NEWCASTLE MEETING, BY JOHN PERCY, M. D., F. R. S.

There appeared in the *Times*, of March 6, 1877, an announcement, in glowing language, of an alleged discovery of Professor Barff, by which iron might be effectually prevented from rusting, and, "however much exposed to weather, or corrosive vapors, or liquids," might be rendered "practically indestructible and everlasting." The process consists in exposing iron to the action of superheated steam, whereby it acquires a tenaciously adherent coating of one of its own oxides, *viz.*, magnetic oxide, which it is asserted protects the underlying metal not only from atmospheric oxidation, but also from that of corrosive re-agents. The fact that magnetic oxide would be formed under those conditions was known to every chemist, notwithstanding the statement of the writer of the article in the *Times*, that it was discovered by Professor Barff. That iron, upon the surface of which a coating of magnetic oxide has been formed by the joint action of heat and atmospheric air, is preserved in a greater or less degree from rusting, is a fact well known, I should suppose, to every member of the Institute, before the announcement of Professor Barff's discovery; and,perhaps the most striking example that can be adduced in proof of such protective action is afforded by a variety of Russian sheet iron. In a pamphlet which I published in 1871, I described the special character of this sheet iron, and communicated such information as I had been able to procure, concerning its manufacture. The following is a quotation from that pamphlet:—"A particular kind of sheet iron is manufactured in Russia, which, so far as I know, has not been produced elsewhere. It is remarkable for its smooth, glossy surface, which is dark metallic gray, and not bluish gray, like that of common sheet iron. On bending it backwards and forwards with the fingers no scale is separated, as is the case with sheet iron manufactured in the ordinary way by rolling; but on folding it closely, as though it were paper, and unfolding it, small scales are detached along the line of the fold * * * This sheet iron is in considerable demand in Russia, for roofing, and in the United States, where it is largely used in the construction of stoves, and for encasing locomotive engines."

Now, from the circumstance of its being applied to the purpose just mentioned, especially roofing in such a climate as that of Russia, it may be inferred that it must be much less liable to rust than ordinary sheet iron; and of the correctness of that inference I have had personal experience. In 1846 I constructed, of this Russian sheet iron, a gas-combustion furnace for organic analysis, which I exhibited to the meeting of the British Association, at Southampton, in the same year. Ever since that period the furnace has been exposed to the atmosphere, sometimes to that of a laboratory, and yet it presents only here and there small spots of rust. Other specimens of similar sheet iron, which I have had in my possession for fifteen years and upwards, remain free from rust, notwithstanding that they have also been freely exposed to the atmosphere.

The metal used for the sheet iron in question is made from pig iron, either in a charcoal finery, or the puddling furnace; but, according to one account, only in the former. The pig iron is produced by smelting magnetite, spathic iron ore, and red and brown hematite with charcoal and cold blast. For a detailed account of the process of manufacture, I must refer the members of the Institute to the pamphlet which I have mentioned; but there is one operation to which I invite their attention, and which is conducted as follows:—The rolled sheets are sheared to the dimensions of 28 inches by 56 inches; and each sheared sheet is brushed all over with a mixture of birch charcoal powder and water, and then dried. The sheets so coated, with a thin layer of charcoal powder, are arranged in packets, containing from 70 to 100 sheets each and each packet is bound up in waste sheets, of which two are placed at the top, and two at the bottom. A single packet at a time is re-heated with logs of wood 7 feet long placed around it, and, for this purpose a furnace of particular construction is employed, which will be found fully described and illustrated in the pamphlet referred to, and a copy of which I herewith transmit. It consists of a re-heating chamber above, and a fire-place below, the two being separated by a floor, containing holes through which the gaseous products of combustion from the fire-place, pass into the upper chamber. The object, it is stated, of the logs of wood is to prevent, as far as possible, the presence of free oxygen in the re-heating chamber. The packet is thus slowly heated for five or six hours, after which it is withdrawn and hammered. Now, during a considerable portion of this period, steam would continue to be evolved from the logs, and it becomes a question whether that steam may not be instrumental in forming a superficial coating of magnetic oxide of iron on the sheets of the packet. But it was not until I had read the account of Dr. Barff's process, that this notion occurred to me. If it should prove to be well founded, then another would be added to the many remarkable instances in metallurgy of practices having been introduced, and long carried on, without even a suspicion of the scientific principles which they involve.

Assuming the correctness of what has been asserted concerning the action of a coating of magnetic oxide of iron in preserving iron from rusting, it seems extremely probable that such action is due in a great measure, if not wholly, to a peculiar physical state of the oxide. One condition is also essential, namely,the perfect continuity of the coating; for I have observed that when an article which had been coated by Prof. Barff himself, and from which the oxide had been expressly removed in one or two places, was exposed to the joint action of air and water, especially salt water, rusting speedily took place at the denuded places, and proceeded with rapidity; but whether more rapidly than in the case of ordinary sheet iron, exposed to similar conditions, I can not state, as no comparative experiments were made. This, however, is a point which will deserve particular attention.

I trust that, in submitting the foregoing remarks to the meeting of the Institute a desire to disparage Prof. Barff's application will not be imputed to me. So far from having any such desire, I have pleasure in expressing my opinion that great credit is due to the Professor, both for the originality of his proposal and for the manner in which he has experimentally investigated the subject.

The next example which I have to submit to the Institute of the protection from atmospheric action afforded to a metal by a coating of his own oxide, is copper, and it is a very striking one. For more than a century, European metallurgists have been familiar with small thin bars of cast copper, of Japanese manufacture, which present a beautiful rose-colored tint, due to an extremely thin and pertinaciously adherent film of red oxide of copper, or cuprous oxide. This tint, according to my experience, is not in the least degree affected by free exposure of the bars to the atmosphere. I have had such bars in my possession for more than thirty years, and, although they have been freely exposed to the atmosphere during the whole of that period, yet they have not undergone the least change in appearance; they remain as bright and as beautifully colored as they were when I received them. Now, as every one knows, when a piece of ordinary copper is exposed to the atmosphere, it speedily acquires a dark-colored tarnish. Hence the conclusion that there is some peculiarity on the surface of the Japanese copper, which protects the underlying metal from atmospheric action, and that peculiarity, it may be demonstrated, is the presence of a film of cuprous oxide, in a particular physical state, which acts like varnish. The bars of Japanese copper are actually cast under water, the metal and the water previously heated to a certain degree, being poured at a high temperature. I have fully described the process in a volume which I published in 1861, and I have recently obtained additional information on the subject from my friends, Messrs. Tookey & Godfrey, who have witnessed this singular process of casting in Japan. I have also succeeded in thus casting copper under water. It would be out of place, on the present occasion, to describe the process in detail. All that need be further stated is, that when copper is so cast, under suitable conditions of temperature, it acquires a coating of cuprous oxide which acts in the manner described. The temperature is such that the so-called spheroidal action of water comes into play, and the metal flows tranquilly under the water. The superficial oxidation is probably due to the action of a film of steam which there is reason to believe surrounds the copper under these conditions; and when copper is heated to a high temperature in steam, the latter, as shown by Regnault's experiments, is decomposed with the evolution of hydrogen and the formation of cuprous oxide.

The last example of the action in question, which I shall mention, is afforded by lead. In the collection of the Museum of Practical Geology, in London, there is a number of very thin sheets of lead, coated with bands of varied and extremely bright colors. Although the atmosphere has had free access to these sheets for about thirty years, the colors are as intense and as bright as they were at first. The sheets were prepared at Mr. Beaumont's smelting works, by dexterously skimming in the process of desilverizing lead by Pattison's most original and beautiful process, and were presented to the Museum by Mr. Sopwith, at that time general manager of Mr. Beaumont's mining and smelting establishments. The colors are certainly caused by excessively thin films of oxide of lead of various thickness.

SUBSTITUTES FOR INDIA RUBBER.*

During the past twenty-five years innumerable attempts have been made by various persons to provide some substitute for India rubber, but none of them have met with much success; and most of the prominent manufacturers of rubber goods in this country are now disposed to sneer at any efforts which are made in this direction. A few, however, retain some faith in the possibility of such an article being discovered, and if it could be produced at a less cost than India rubber, it would certainly make the fortune of the discoverer or inventor; for the various rubber manufacturers of the United States now consume over $5,000,000 worth of raw rubber and gutta-percha per year. The total importations of crude rubber and gutta-percha into this country for the year ending June 30, 1877, were valued at $5,542,166.

A gentleman who resides in Seymour, Conn., and is a nephew of the original discovery of the process of vulcanization, has been at work nearly all his life endeavoring to produce a perfect substitute for india rubber. He now manufactures an article which he calls "kerite," which is employed to some extent for insulating telegraph wires. Its principal ingredient is crude petroleum, but it also contains coal tar, sulphur, vulcanized linseed oil (or cotton-seed oil) and 25 per cent. of vulcanized india rubber; after those substances have been compounded together, the compound is again vulcanized, and its manufacture is then complete. This gentlemen exhibited his inventions at the Centennial Exposition, and he applied the "kerite" in a liquid form to various articles—among others to linen or cotton cloth (cambric), for the purpose of showing how it might be used in manufacturing light and pliable water-proof garments to take the place of our present "gossamer rubber cloaks" or of the English "Mackintoshes," for ladies' wear. There is scarcely any possible purpose to which this enthusiastic inventor has not endeavored to adopt "kerite," and he is probably better posted than any other man in the world on the subject of a substitute for india rubber. He has sought for the coveted substance as earnestly and laboriously as ever the alchemists of old sought for the philosopher's stone, and his attic is said to contain tons of old rubbish representing years of unsuccessful and apparently unprofitable toil in his pursuit.

There is an ambitious young chemist in this city who has also been working for a few years past on a substitute for india rubber. He, and some others who are associated with him, make a liquid substance which they call "Tunyoap," for varnishing ships bottoms, &c. They are also just introducing the substance in another form as a water-proof dressing for boots and shoes, and the manufacturers of the gossamer cloaks are experimenting with the "Tunyoap" to see if it can possibly be made to take the place of india rubber on their fabrics.

A physician who also resides in a section of this city, is experimenting with the juice of the common "milkweed," (*Asclepias Syriaca* or *Cornuti*), which is so common in this part of the country to see if it can't be made to take the place of india rubber, and the gossamer rubber manufacturers either have, or profess to have, some faith in the possibility of his success.

Possibly efforts are also being made in a small way, from time to time, by many other parties to invent artificial caoutchoucs, but they never made progress enough to attract any attention. Crude petroleum seems to be the chosen material on nearly all the theorists on this subject, and it has formed the basis of a great portion of the experiments which have been made by seekers for this modern "elixir."

*Boston Com. Bulletin.

EFFECTS OF HEAT UPON THE FIRE SHEETS OF BOILERS.

Iron plates made from the piling and rolling of bars, are not unfrequently laminated from imperfect welding, caused mainly by small particles of scoria which intervene between the laminated surfaces. When such plates are subjected to a high temperature on one side, as in the case of fire sheets in steam boilers, the defect is manifested by blisters of greater or less extent, and of a thickness corresponding to the thickness of the outer lamina. In some instances three and four distinct laminæ are found, which are usually called so many "leaves." The outer surface of the fire sheets of a boiler is subjected to a temperature of upwards of 1200 degrees; while the inner surface, protected by the boiling water, will be from 212 degrees to the temperature resulting from the pressure of steam in the boiler. It was formerly put at 212 degrees, but inasmuch as the steam generated at the surface is constantly passing up through the water into the "steam room" of the boiler, where the accumulated and superincumbent pressure is increasing in temperature, it is fair to estimate the temperature of the inner surface of the plate at least as high as the temperature due to the pressure of steam. We will suppose that a boiler is running at a pressure of sixty pounds per square inch. The temperature due to this pressure is about 295 degrees. It will be seen from this that the difference in temperature of the outer and inner surfaces of the plate is some 950 degrees. Now, if the plate is imperfect or laminated, the greater expansion of the exterior surface will cause it to rise up in blisters.

From the foregoing it is evident that blisters are occasioned by a want of solidity and homogeneity in the iron. If the bars which form the pile are clear and free from rust or scoria, and are well welded in the process of rolling, the great difference between the temperature of the two sides produces apparently no injurious results. When the heat of the furnaces impinges against the fire surfaces, if the plates are solid and homogeneous, and the boiler free from scale, the thermal conduction is complete; but, on the contrary, if the sheet is laminated, resistance is offered to the conduction of heat, and the outer surface, being overheated, rises up in the form of a blister. Any obstacle intervening to prevent the free conduction of heat, results in overheating the part between the fire and the intervening obstacle. Hence, if scale accumulates on the inner surface of the boiler so as to prevent the water from coming in contact with the metal, the iron is liable to be greatly overheated and its strength greatly reduced. The outer lap of fire sheets are often found fractured, from the rivet holes out to the edge, or in the line of the rivet holes. This is caused by the outer portion being overheated in consequence of the resistance offered to the free conduction of heat. The two plates coming together, act in the same manner as a laminated sheet, except that at the joints they are so bound together and the lap is comparatively so short, that instead of bulging, as in the case of a blister, the iron becomes fractured and worn away. Therefore an externally fired boiler should be so constructed that the first sheet should overlap the second. This will prevent the flame from impinging against the edge of the sheet, and diminish, in some measure, the danger of rapid deterioration. The longitudinal seams should be well up on the sides of the boiler, beyond the action of the fire. Careful examination of boilers which have been long in use will generally show a thinning down of the plate at the outer lap. This may be in some measure due to impurities in the coal, but it is also due to the impediment offered to the free conduction of heat, in consequence of which that portion of the sheet is overheated and worn away. It will be noticed, in connection with boilers of considerable age, that the rivet heads in and near the furnace are much worn away. This arises from the fact that they derive little protection from the water within the boiler. The heads being riveted down and projecting beyond the edge of rivet hole, present the same resistance to thermal conduction that laminated sheets and overlaps do, only that this difficulty is in addition to the others, and the result is more manifest and more easily detected. It must not be forgotten that impure coal is an active agency in this wearing process. The question has been asked, "How thick can iron be and not be injured by a fire on one side while there is water on the other, as in the case of a boiler?"

From the foregoing it will be seen that the homogeneity of the iron, freedom from scale on the inner surface of the plate, and character of fuel, have much to do with the solution of this question. Formerly it was a difficult matter to roll boiler plates of one-half, or three-quarters of an inch thick, free from laminations, which had much to do with their increased resistance to thermal conduction. The difficulty now however is mostly overcome, and the process of rolling plates from ingots of soft steel gives a product of almost perfect solidity and homogeneity, and one which offers the least resistance to the transmission of heat. It is nevertheless true, that the evaporative efficiency of a boiler depends largely upon the thickness, as well as upon the nature and condition of the material forming the heating surface. In a homogeneous plate, the resistance to the conduction of heat is directly in proportion to the distance which the heat has to travel, or to the thickness of the plate, and inversely to the difference of temperatures between the inner and outer surfaces. From experiments which have been made with new boilers, constructed of one-half and three-eighths inch plates, the steaming qualities have been found in favor of the thinner plate at first, but when the plates have become coated over with layers of oxide on one side, and scale and grease on the other, the difference in efficiency is not apparent. It is believed by many engineers that there is a gradual diminution in the thickness of boiler plates by the action of heat until they are about five-sixteenths of an inch, which seems to be the thickness that will transmit heat with just the rapidity that will keep the fire surface below a wasting temperature. This is said to have been particularly noticed in connection with railroad locomotive boilers. In our own experience we have found that the fire sheets of externally fired boilers of great age are very perceptibly thinned, even where the original thickness was not more than one-quarter or five-sixteenths of an inch. Portions of the boilers not acted upon by the fire showed none of this wearing-away process. How much the thinning may have been due to impure fuel cannot be positively stated, but such facts as could be gathered indicated that a good quality of fuel had been used. Some of these boilers were thirty years old. Strips were cut from the fire sheets and tested as to their condition and strength. In some cases these would be found soft and ductile, and apparently little injured in quality by the long use to which they had been subjected. In others the structure had become crystalline, and the fracture was short and the metal brittle. The fire sheets of boilers are so often renewed after a few years' use, it is difficult to get reliable data bearing upon the long-continued action of heat upon iron plates. There is little doubt but that the steaming qualities of a boiler constructed of quarter-inch iron would be superior to one constructed of one-half inch iron; and it might further be said, that one constructed of one-eighth inch iron would be better than either, from the fact that there would be less resistance to thermal conduction. But it must not be forgotten that the construction of boilers often involves the use of metal not only one-half inch, but even three-quarters of an inch, and in rare instances one inch thick, in order to withstand the internal pressure, and provide at the same time a good margin for safety.

The conclusion would seem to be that there is no definite thickness of plate that will transmit heat with just the rapidity that will keep the fire surfaces below a wasting temperature, or, if there is such a thickness, it is next to impossible to ascertain it, on account of the difficulties with which the use of boilers is surrounded in consequence of imperfect metal, impure water, and fuel impregnated with extraneous substances.

J. M. ALLEN,

Office Hartford Steam Boiler Inspection and Insurance Company.

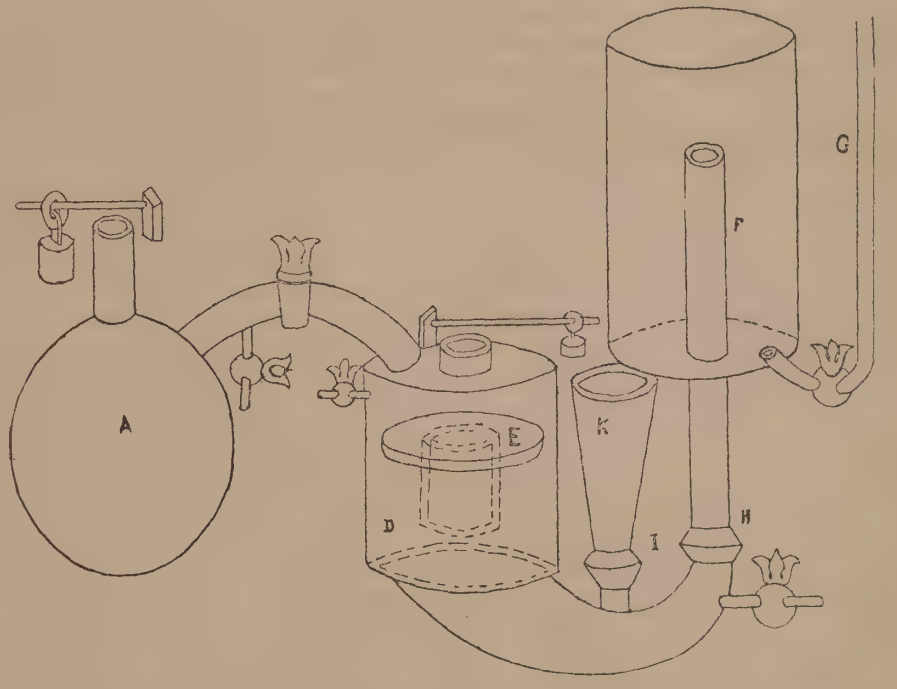
Hartford, November 14th, 1877.

PAPIN'S STEAM ENGINE.*

It is a matter of history that, as early as 1688, Denis Papin, Professor of Physics and Mathematics, in the University of Marburg, proposed to substitute steam for powder in the engine invented by Huyghens, and that, in 1695, he published a description of several new inventions, in which steam played an important part. The Elector Carl, of Hesse-Cassel, was anxious to be free from the annoyances and impositions practised upon his boatmen by the authorities at Munden, and he proposed to avoid that city by constructing a canal connecting the Weser with the river that flowed through Cassel. Much of the work was accomplished, and the half finished line of the canal can be traced even at the present day. Papin was authorized to build a powerful steam pump, by which the supply of water was to be regulated. A working model of this pump was completed, and the Elector was on the point of visiting the laboratory to witness its operation, when a fearful explosion frightened the workmen, and afforded an opportunity for enemies to intrigue for the expulsion of Papin from the country. The model was preserved for a long time in Cassel, but at the time of the French invasion it disappeared, and no trace of it has since been found.

One of the cylinders which was to form a part of the pump was cast at the foundry in Cassel, and after various vicissitudes has finally become the property of the Historical Museum of that city.

A copy of the drawing, made by Papin, of the pump in which this cylinder was to form a part, and which was published in 1695, is represented herewith.



A is the boiler for the generation of steam, provided with a safety-valve (an invention of Papin). On opening the stop-cock *C*, the steam passes through *B* into the cylinder *D*, and by its expansion drives the plunger *E* against the water contained in the cylinder, and which is thus forced into the chamber *F*, compressing strongly the air, which in turn expels the water through the pipe *G* to the height desired. *K* is a funnel for the fresh supply of water, and at *I* and *H* are valves opening upwards and downwards. After the condensation of the steam in *D*, a renewed supply of water through *K* forces the plunger *E* to the top of the cylinder, ready for the next action of the steam.

It appears that Papin also constructed a steamboat, and petitioned the Councillors of State for a permit to pass therewith from the river Fulda into the Wesser. This petition, sent by Leibnitz, the librarian of the Hanoverian library, was dated July 13, 1707, and was formally refused on the 25th of the same month. The failure of this petition was the death-blow to Papin's efforts to establish steam navigation. A mob of boatmen, who thought they saw in the embryo ship the ruin of their business, attacked the vessel at night and utterly destroyed it. Papin narrowly escaping with his life, and fled to England, where he endured great hardships and poverty, and all traces of him were soon lost, so that it is uncertain in what country he finally died or where he was buried.

* Extracted from a communication by Prof. Charles A. Joy. See *Sci. Amer.*, xxxvi, 120.

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SLIDE VALVE GEARS.

By HUGO BILGRAM, M. E.

PART III.

THE BILGRAM CUT-OFF GEAR.

The described gears, adaptable to valves arranged as shown in Fig. 58, have been shown to cut off rather sluggishly—almost throughout with less speed than the main valve alone would—owing either to their very nature or to the practical limitation of certain proportions. The present valve-gear is designed to overcome this difficulty.

Both valves (see Fig. 58) are operated by one single eccentric *I*, Fig. 77; the main valve directly by the eccentric rod,

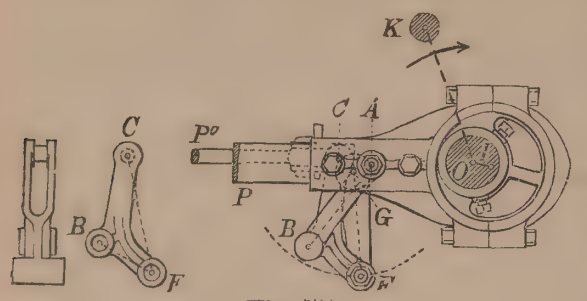

Fig. 77.

and the cut-off valve through a peculiar mechanism, consisting of four members, viz: the link, the rocker, the cut-off rod and the adjustment lever. The link *AB* being jointed by the pin *A* to the eccentric rod, imparts to the rocker a rocking motion on its fulcrum *F*. The rocker is of a peculiar shape, as shown detached in the cut, but it virtually represents a bell-crank (or angular lever), having an angle *BFC* of about 50°, the arm *CF* of which is about twice as long as the arm *BF*. To the extreme end *C* of this rocker is jointed the cut-off rod, by which the cut-off valve is moved. For the purpose of changing the degree of expansion, the fulcrum *F* of the rocker can be moved in a circular arc, being attached to the end of the adjustment-lever *GF*, whose fulcrum *G* is a fixed point.

The study of this gear will consist in the investigation of the movement of the cut-off valve for several positions of the adjustment-lever. In every case we shall proceed from the neutral position of the rocker (found by transferring the eccentric rod to the centre of the crank-shaft) remembering that the movement of the mechanism will be symmetrical to both sides of this position. Besides, we shall as usual neglect all complicating influences resulting from the angularity of the several members; in other words, we shall assume the movement of the pin *A* to be strictly circular and coincident with the movement of the eccentric *I*.

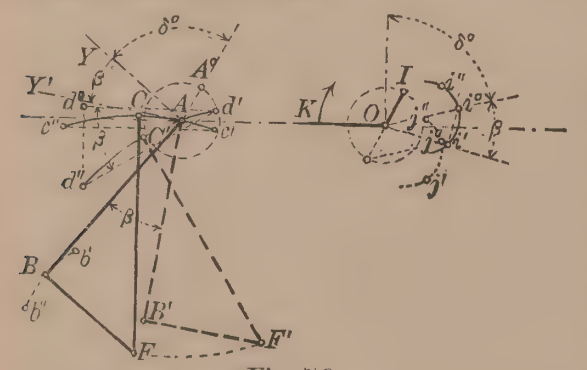

Fig. 78.

At first we move the adjustment-lever until the line *CF* of the rocker assumes a vertical position (see Fig. 78), the theory for this position being the least complicated. When the mechanism is in operation the pin *A* will move in a circle, and hence the points *B* and *C* will move in the arcs *b'b''* and *c'c''*. For the latter arc we shall substitute the chord to simplify the theory. When the crank is on its centre the pin *A* will occupy the position *A°* corresponding to the position of the eccentric *I*, and since the link *AB* represents, as it were, the eccentric rod for the cut-off gear, we can measure the angle of advance, $\delta° = YAA°$, by drawing *AY* at right angles to *BA*. The angle *CFB* being 50°, and *AB* being at right angles with *FB*—or approximately so—it is evident that the angle $YAA° = \delta°$ exceeds the angle of advance of the eccentric, *I*, by 50°. Owing to the dimensions of the rocker, the travel of the point *C*, and consequently also the travel of the cut-off valve, equals double the movement of the main valve; and hence we can find the ideal eccentric *i°* of the movement of the cut-off valve for the considered grade by advancing the line *OI* through an angle of 50° and doubling its length.

Next we move the fulcrum *F* towards the right to *F'* to change the grade, and denote the angular change of the rocker by the Greek letter *β*. The corresponding angular change of the link *AB* is practically the same, and the angular advance is consequently farther increased by this angle. We can therefore draw the line *Oi'*, but we have yet to find its length. The movement *d'd''* of the pin *C'* of the rocker is doubtless the same as it was before; but being inclined, it is only its horizontal component *d'd°* that is transmitted to the valve, and the throw *Ci'* of the ideal eccentric for this grade will be less than *Ci°*. The necessary reduction can be made by drawing the line *i°i'* at right angles to *Oi'*, which will be understood when we consider the similarity of the triangles *Oi'i°* and *d'd°d''*.

In moving the fulcrum *F* of the rocker in the opposite direction we would have found the ideal eccentric *i''*, and other positions of the fulcrum *F* would furnish more points of the locus of ideal eccentrics. The angle *i°i'* being a right one, it will easily be understood that all the ideal eccentrics will be located in a circle of which the line *Oi°* is a diameter.

These results relate to the absolute movement of the valve and to find the ideal eccentrics for the relative movement, we move the locus in the direction of and through a distance equal to *IO*. Having thus determined the locus *j'i°j''* of the relative movement, we can draw the valve diagram, Fig. 79, in the usual manner.

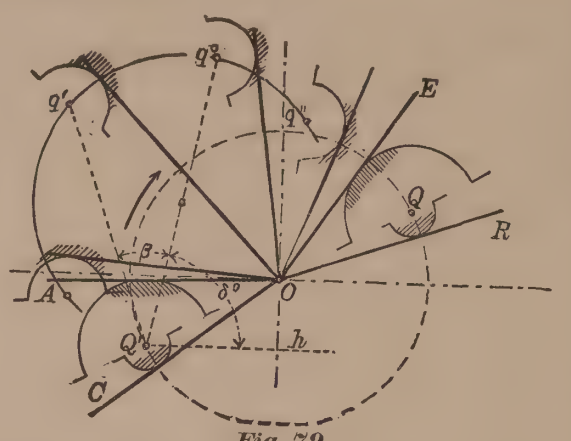

Fig. 79.

This diagram now shows that the cut-off can be adjusted to any point between the crank angles *OA* and *OE*, as the angular adjustment of the rocker is not limited. It shows, moreover, that this valve-gear is distinguished by the decided rapidity in cutting off. The closure of the steam passages is very sharp for all grades cutting off before the half-stroke; for a later cut-off, however, this rapidity will get less until, when cutting off at *OE*, the rapidity of the cutting off of the cut-off valve will about equal that of the main valve.

The rapidity of late cut-offs can be improved, if desired, by making the arm *CF* of the rocker more than double the length of the arm *BF*; whereby, the line *Oi°* will be lengthened and consequently the locus-circle will be enlarged. This change entails an increase of the absolute movement of the cut-off valve above twice the travel of the main valve. Another measure consists in increasing the negative lap of the cut-off valve; but for reasons discussed in the foregoing chapter, it should never exceed the positive outside lap of the main valve. A reduction of the angle *BFC* of the rocker would likewise be efficient, but this reduction is attended by an increase of certain irregularities.

The sharpness of the cut-off will in reality be slightly less than indicated in the diagram, from the fact that the movement of the pin *A* is not circular as was assumed, but is more or less flattened.

The proportioning of the mechanism requires some care; for on it depends largely the proper operations and regularity of the cut-off. To this end we draw the rocker *FC* (Fig. 80) *B*

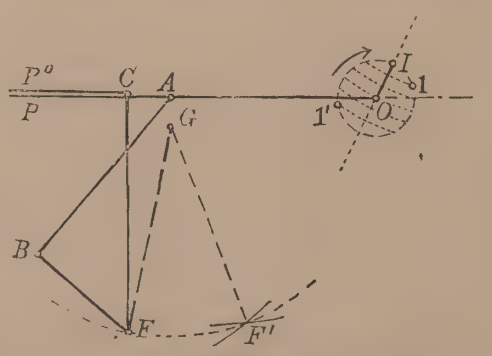

Fig. 80.

with the line *CF* in a vertical position, and the line *BF* at an angle of 50°, and make the arm *BF* from three to four times the throw of the eccentric, and the arm *CF* twice as long. (The given figures have been tested by a number of experiments). Then we draw the link *AB* at right angles to *BF* and make it about $\frac{6}{7}$ of the length of *CF*. The eccentric rod *OP* can next be shown in its neutral position, passing through the end *A* of the link. The cut-off rod *CP°* can likewise be shown.

To find the length and position of the adjustment-lever *GF*, it is necessary to make a model of thin wood or veneer, consisting of the eccentric rod, the link, the rocker and the cut-off rod. Next we draw the orbit of the eccentric, and on it the exact position of the eccentric, say for every one-sixth of the stroke of the piston, which may be done in the following way, identifying the eccentric path with the path of the crank-pin: We divide the diameter of the orbit passing through the initial position of the eccentric *I* in six equal parts, and draw the projection arcs of the proper radius through those points, as shown. The next thing to be done is to attach the model to the drawing by joining the parts properly together with pins or thumb-tacks, and fastening the ends *P* and *P°* of the rods to two slides representing the valves. The right end of the eccentric rod may be provided with a needle point which at first we put in the centre *O*, when we set the rocker directly over the position shown in the drawing, and mark the relative position of the two slides representing the valves. Then we make two additional marks on one of them, at a distance equal to the assumed negative lap of the cut-off valve, to show the relative position for the cutting off on either side. Suppose now we desire to find the proper position of the rocker for cutting off at the point 1. To this end we set the needle-point of the eccentric rod in the point 1 of the fore-stroke, and fix the valves for cutting off at the proper side, when we will find that the end *F* of the rocker cannot be moved but in a certain curve. This curve we mark on the drawing by setting a needle-point into the rocker and making a slight scratch on the paper. Thereupon we attach the eccentric to the point 1′ of the return stroke, fix the cut-off valve to the point of closure of the other passage of the main valve, and mark another curve by the point *F* of the rocker. The juncture *F'*, of these curves, must of necessity, be the exact position of the fulcrum of the rocker when we desire to cut off at one-sixth of the stroke. In this way we can find the required position of the fulcrum for all the other grades, which will be found to form a curve. By substituting a circular arc for this curve, osculating as closely as possible, we obtain the location and length of the adjustment-lever *GF*. An arc can generally be found to agree with the constructed curve with an almost absolute precision; and hence it will be seen that this valve-gear will admit of a practically perfect equalization of the difference between fore and return stroke.

Zinc Coated Sheet-Iron.—The popular that idea the substitution of zinc for tin is merely an economical one is erroneous, for the former is far less susceptible to oxidation than the latter, and is perhaps less affected by atmospheric influences than any other metal. This circumstance is of special importance with regard to zinc coated sheet-iron, for on the surface of this a thin film of oxide is formed, which so thoroughly protects the metal from further oxidation that a thin sheet of sheet-iron thus coated will last for years. Roofs of "zinced iron" do not wear out from oxidation, and do not crumble as does sheet-tin from the repeated contraction and expansion produced by changes of temperature. Roofs of sheet-iron coated with zinc, therefore, are not only cheaper, but far more serviceable than those of sheet-tin. In Vienna and Prague the manufacture of this roofing metal is a growing industry, whilst in England upwards of 180,000 cwt. were manufactured in a single establishment.—*Bair Ind. Ul Gewerbe*

Vermicelli.—This article of food is the paste of wheat flour drawn out and dried in slender cylinders more or less tortuous, whence the Italian name. The *gruau* of the French is wheat coarsely ground so as to free it from the husks; the hardest, or whitest part, being separated by sifting, is preferred for making the finest bread. When this *gruau* is a little more ground and the dust separated from it by the bolt, the granular substance called *semoule* is obtained, which is the basis of the best pastes. Twelve pounds of soft and pure water are used in kneading fifty pounds of the *semoule* or middlings. The water should be hot and the dough briskly worked while still warm. The Italians pile one piece of this dough upon another and tread upon it for two or three minutes, it is afterwards worked for a couple of hours and when properly prepared is reduced to thin ribands, cylinders or tubes by means of a powerful press to form vermicelli and macaroni of different kinds. Vermicelli is made with most advantage from the flour of southern countries which is richest in gluten. It may also be made from our ordinary flour, provided an addition of gluten is made to the flour paste. When made from the northern flour, however, it is apt to melt into a paste when boiled in soups.—*American Miller*, v, 205.

A List of the Rivers of England, laid before the House of Lords' Select Committee last Session on Conservancy, Drainage and Navigation Boards, gives the following as the rivers having catchment basins of above 1000 square miles:—The Thames, which is 201 miles in length, and has tributaries of the united length of 463 miles; the Severn, length 178 miles, and tributaries 450 miles; the Trent, 167 miles, and tributaries 293 miles; Ouse (Cambridge), 156 miles and tributaries 212 miles; Wye, 148 miles, and tributaries 223 miles; Nene, 99 miles, and tributary 11 miles; Witham 89 miles, and tributaries 75 miles; Mersey, 68 miles, and tributaries 188 miles; Ouse (York), 59 miles, and tributaries 629 miles; Humber, 37 miles, and tributaries 55 miles; Tyne, 35 miles, and tributaries 174 miles. The catchment basin of the Medway is only three square miles below 1000; the length of that river is 69 miles, and its tributaries 62 miles.

PROGRESS IN SCIENCE AND THE ARTS.

☞ This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.

CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Advantages of Petroleum Lubrication.—A conservation, founded more on prejudice and want of proper information than any thing else, has existed for some years; it clings to the use of animal oils in defiance of reason and economy, but, like all the so-called conservatism, it is gradually yielding to the advancing scientific spirit of the age. There are but few cases in which mineral oils cannot supersede the vegetable and animal oils. Oils from petroleum are now produced suitable for nearly every mechanical process for which the animal oils have heretofore been used, not excepting those intended for cylinder purposes. A serious objection attaching to the animal oils is present in petroleum. If, through the exhaust steam, some of the oil be carried into the boiler, foaming or priming is the consequence, but the same thing happening in the case of petroleum is rather of benefit than otherwise, for it not only does not cause foaming, but it prevents incrustation or adhesion of the scale or deposit, and this aids in the preservation of the boiler, and is, perhaps, the best preventative of the many everywhere suggested.

Often in removing the cylinder-head and plate, covering the valves of an engine, we see evidences of corrosion or action on the surfaces, differing entirely from ordinary wear, and the engineer is generally at a loss how to account for it. According to the gradual impression, grease or animal oil is the preservative of the metal, and is the last thing suspected of being the cause of its general disintegration. The reason of this is that vegetable and animal oils consist of fatty acids, such as stearic, magaric, oleic, etc. They are combined with glycerine as a base, and, under ordinary conditions, are neutrals to metals generally, and on being applied they keep them from rusting by shielding them from the action of air and moisture. But in the course of time the influence of the air causes decomposition and oxidation, the oils become rancid, as it is called, which is acid, and they act on the metals. What happens at the ordinary temperature slowly, goes on rapidly in the steam-cylinder, where a new condition is reached. The oils are subjected to the heat of high-pressure steam, which dissociates or frees these acids from their base, and, in this condition they attack the metal, and hence destroy it.

This applies as well to vegetable as to oils of animal origin, fish or sperm oil included. Petroleum, and oils derived therefrom (generally called mineral oils), are entirely free from this objection. Petroleum contains no oxygen, and hence it cannot form an acid, and therefore cannot attack metal. It is entirely neutral, and so bland that it may be, and is, used medicinally as a dressing to wounds and badly abraded surfaces where cerates of ordinary dressing would give pain.

The editor of this journal has, since 1866, repeatedly been calling attention to these facts, and now at last we see that they commence to be adopted, and even brought forward as a new discovery by the industrial journals in England—a country very slow in adopting new ideas, especially if they come from this side of the Atlantic.—*Saward's Coal Trade Journal*, xiv.

A Recording Telephone.—Mr. Edison, the inventor of many improvements in telegraphy, is hard at work in the endeavor to make the telephone record the sounds it transmits. His apparatus at present consists chiefly of a steel point attached to the disk of a telephone, and pressing lightly on a strip of paper beneath the point at a uniform rate. The vibrations of the disk are thus recorded, and can be translated. Mr. Edison has already achieved some success in this attempt, but as yet finds difficulty with the more delicate vibrations. The invention suggests an ultimate possibility of reporting a speech at a distance, verbatim, without the need of shorthand.—*N. Y. Tribune.*

New Means for the Production of Cold.—M. C. Vincent has obtained, in distilling the residues of beet molasses, a large quantity of chlorhydrate, cromhydrate and iodhydrate of trimethylamine. The same chemist has given to the Academy of Sciences a method of transforming these compounds to chloride of methyle, and pointed out the applications to which this compound is susceptible. At 35° below zero the chloride is liquefied, and can be kept in that state in sealed tubes. On evaporating this liquid at refrigeration of 55° is obtained. A considerable reduction of temperature can therefore be easily and cheaply obtained.—*Revue Industrielle.*

Preparation of Platinum Sponge.—According to a communication made by Prof. Böttger to the *Physikal Verein zu Frankfort*, platinum sponge may be prepared by adding a small quantity of double tartrate of soda and potassa to a solution of platinum chloride, and boiling the same. During the violent evolution of carbonic acid gas, all the platinum is deposited, as platinum sponge and nothing is necessary but drying the latter on filter paper.—*D. Ind. Ztg. per Allgem Polytechnische Ztg.* v, 477.

Electric Illumination.—Some elaborate experiments have recently been made in England, with magneto-electric machines, mounted at the South Foreland light houses. These experiments were made with machines constructed by different makers, and the object in making the tests was to determine the relative merits of the machines. In a report by Professor Tyndall, published in the last number of *Engineering*, he says: "The new machines mark a great advance, both in economy and power, as regards the application of the electric light to lighthouse purposes." He further says that "Siemens' and Gramme's inventions undoubtedly place at the disposal of the Elder Brethren, electric lights, of surpassing energy; transcending in power and individuality all other lights now existing."

The smaller Siemens' machine, which was decided to be superior to any of the others, measures 2 ft. 2 in. long×2 ft. 5 in. broad and 10 in. high, and weighs 420 lbs. With 850 revolutions per minute, and a consumption of 3.3 horse-power, the condensed beam of light was equivalent to 6,864 standard candles, the diffused beam to 4,138 candles. The cost of these machines is $375. The larger Siemens' machine measured 3 ft. 9 in.×2 ft. 5 in.×1 ft. 2 in. and weighs 1,306 lbs., with 480 revolutions per minute and 9.8 horse-power; the condensed beam was equivalent to 14,818 standard candles, and the diffused beam to 8,932 candles. Its cost is $1,375.

The electric light has already been used in France for the illumination of railroad stations, and these experiments indicate that the recent development of the art, and the improvement of the machines has placed at our disposal a light which will soon be generally employed for illuminating purposes, especially where it is necessary for lights to penetrate to great distances, as at sea, or possibly for head lights for locomotives, etc.

The experiments of Professor Tyndall indicate that the art has now passed the experimental stage, and that electric illumination is about to enter a period of general introduction for practical purposes.—*Railroad Gazette*, ix, 499.

A Process for Making Glass Iridiscent has been patented by M. Clenandot. Beautiful effects are produced. The main feature of the process is the application of acids to the glass, under a pressure of from two to five or more atmospheres. Water containing 15 per cent. of hydrochloric acid, is used to bring out rainbow tints like mother-of-pearl, and artificial gems, of various sorts, have thus been manufactured. The glass prepared by these processes is quite as iridiscent as is that which antiquarians so much value; the pressure and the acids hastening a result that the ordinary agencies of the atmosphere would take centuries to produce.—*N. Y. Tribune.*

Cleansing Feathers of their Animal Oil.—The following recipe gained a premium from the Society of Arts: Take for every gallon of clean water one pound of quicklime, mix them well together, and when the undissolved lime is precipitated in fine powder, pour off the clean lime water for use. Put the feathers to be cleaned into another tub, and add to them a quantity of clean lime water, sufficient to cover them about three inches, when well immersed and stirred about therein. The feathers, when thoroughly moistened, will sink down, and should remain in the lime water three or four days, after which the foul liquor should be separated from them by laying them in a sieve. The feathers should be afterwards well washed in clean water and dried upon nets. The feathers must, from time to time, be shaken on the nets, and, as they get dry will fall through the meshes, and are to be collected for use. The admission of air will be serviceable in drying. The process will be completed in three weeks, and after being thus prepared, the feathers will only require to be beaten to get rid of the dust.—*Mining & Scientific Press*, xxxv, 279.

Carbolated Camphor.—In the *Bulletin de Therapeutique*, M. Soulez describes the new preparation known as carbolated camphor, now becoming quite popular in European Medical practice on account of its tendency to produce diminution of re-action after severe operations, cessation or amelioration of pain and less abundant suppuration. It is made by dissolving 2.5 grams of powdered camphor in one gram of carbolic acid—a solution of the strength of nine grams in one grain of alcohol—the solution being of an oleaginous consistency, pale yellow, smelling slightly of camphor, but having none of the disagreeable odor of carbolic acid. It boils at a slightly elevated temperature, without decomposing, and also by the addition of concentrated alcohol, which throws down the camphor in crystals; similarly if a boiling solution of carbolated camphor is poured into cold water it instantly solidifies. It is miscible in all proportions with olive and almond oils. Chemical examination shows that the carbolic acid and camphor are not altered, and that they preserve all their properties in the solution.—*N. Y. Tribune.*

Nitrate of Lead as a Deodorizer.—A correspondent of the *London Lancet* recommends nitrate of lead as a most effective deodorizer. Bad smells, he says, from whatever cause they may arise, are removed as if by magic by its use; it is also remarkably inexpensive, a pound of the material costing less than a shilling, and in combination with common salt, furnishing sufficient to make nearly four hundred gallons of the fluid. To prepare it for use, it is simply necessary to take, for ordinary purposes, half a dram of nitrate of lead, dissolve it in a pint or more of boiling water, dissolve about two drams of common salt in a pail of water, pour the two solutions together and allow the sediment to settle. All that is required in order to immediately purify and sweeten a fetid atmosphere, however originated, is to dip a cloth in the liquid and hang it up in the apartment,

Uses of Crookes' Mill.—It now promises to become a useful tool for various practical purposes.

As velocity of its rotation depends upon the intensity of the light, it is a reliable instrument to measure the value of illuminating gas, and compare it with any adopted standard. When, for instance, it has been found that a certain instrument makes 20 revolutions per minute when exposed to the light of a standard candle, at the distance of say 6 inches, a gas flame which excites twice or four times this velocity, will be a 2 or 4 candle light; or it may be placed at such a distance as to sustain the same velocity of rotation, when the squares of the comparative distances will give the comparative intensities.

The instrument demonstrates directly the law that the intensity of light decreases at the inverse ratio of the squares of the distances. For instance, if a candle placed at a distance of six inches causes 40 revolutions per minute, at three inches or half the distance it will give 4×30 or 120 revolutions; at 12 inches or double the distance it will give ¼×40 or 10 revolutions per minute, and so on. It may therefore be used before a class of physics, to demonstrate an important law in optics, of extensive application in astronomy as well as in the art of determining the value of various kinds of artificial flames used for illumination.

The instrument may be used by photographers. Placing it near the sitter, the operator may observe how many revolutions it takes to make a good picture; and then he may for the future, count, not the number of seconds, and make them longer or shorter in proportion as he guesses the light to be stronger or weaker than usual, but simply count the number of revolutions of the instrument. If once, with say 20 revolutions per minute, he made a good picture, he may be pretty certain that, if the light is only half as strong and requires double the time of sitting, the instrument will occupy twice as much time to make the 20 revolutions; and when, inversely, the light is say one-fourth stronger, requiring one-fourth less time sitting, the instrument will go just so much faster, and make the 20 revolutions in exactly so much less time.—*Manufacturer and Builder*, ix, 241.

American Gum Arabic.—The mesquite gum of Western Texas is almost identical with gum arabic. During the past year it has become an article of export, some 12,000 pounds having been gathered in Bexar county, and as much more between that and the coast. This gum exudes from the stem and branches of the mesquite, a mimosa, several species of which grow in Texas, New Mexico, and Arizona.—*Manufacturer and Builder.*

ENGINEERING—CIVIL AND MECHANICAL, &c.

The Improvement of the Mississippi.—Capt. Eads is lecturing upon a plan for the improvement of the Mississippi, which would render it navigable for large vessels as far as the mouth of the Ohio. In a recent lecture in Cincinnati, he said:

"Any system of levees which attempts to inclose these wide places in the river, will retain the fruitful cause of its own failure and entail untold cost for maintenance, because the levees are the cause of the rapid destruction of the banks the crevasses and the cut-offs. They arrest the uniform and speedy passage of the floods to the sea, for, at each one of them the current is retarded and the flood hight elevated.

"I do not propose to grapple with the floods, but with the causes which produce them. Throughout the entire basin we see repeated illustrations of the fact that the greater the volume the lower the slope. Turn the waters of Red river down the Mississippi, by closing Atchafalaya, and we will increase the volume and reduce the slope. If it were reduced from the passes to Red River, only a quarter of an inch, it would lower the high water mark nearly seven feet at Red River, and the same amount all the way up. It would then be steeper than it is for one hundred miles below New Orleans. Outlets are pernicious, and inevitably raise the flood line. The river

should be brought to a uniformity of width, and where its volume is subdivided by islands, it should be confined to a single channel. I do not propose to shorten or straighten the river. Mature study has convinced me that no cut-offs will be needed to reduce the flood line below the level of the land. I once thought that one or two might be required. The treatment I propose is distinctly a high water treatment. A uniformity of width of its banks will insure a uniformity of depth, and not less than twenty feet from Cairo to the sea in low water. A uniformity in width will bring a uniformity of current, which will more rapidly discharge the floods, and it will stop the caving of the banks.

"This plan is radically different from the plan of the United States Commission of Engineers. It is different in design in the theory and in the assumption of existing conditions in the bed of the river. The commission believes there exists in the bed of the river strata of 'hard blue clay of older formation, which resists the action of the current 'almost like marble.' I believed the river made the bed it flows in from Cairo to the sea, and that the current can take from it and add to it with rapidity and ease wherever it is made quick or slow. The commission does not believe there is any relation between the velocity of the current and the quantity of sediment carried in the water. I believe that every atom of sand or earth, from the moment it enters the river until it is bathed by the salt waters of the Gulf, is controlled by laws as fixed and certain as those that rule the planets.

"In anticipated results these plans are immensely different. One contemplates the flood waters rising from ten to twenty feet above the surface of the land between levees, which must involve an enormous and never ending outlay for repairs and maintenance, with no improvement of the river channel. The other, in effect, lifts above the floods forever, an area equal to the States of Massachusetts, Vermont, Rhode Island, Connecticut and New Hampshire, and opens up 1,100 miles of navigation to the largest ocean shipping into the very heart of the Mississippi Valley. It removes from the channel the snags that now infest it, prevents cut-offs and caving banks, and dispenses with the costly and uncertain system of levee protection, without imposing any important burden of maintenance upon the country.

"Wonderful as these promises seem, there is little doubt in the minds of those who have intelligently studied the action of the currents in rivers flowing through alluvial soils, that the results mentioned can be attained and twenty feet of water carried rom New Orleans to the Ohio."

Improving the Ohio River.—A meeting of the Ohio River Improvement Commission was held recently, at Pittsburgh, Pa. The principal object of the meeting was to hear the report of the executive committee, which was submitted by its chairman, Mr. Thurston. It reviews the progress made in the improvement of the Ohio, which "has been vexatiously delayed by misjudged opposition." The government engineers were prevented from prosecuting their labors on the Davis Island dam, by the delay of the State of Pennsylvania in granting jurisdiction over the ground for the lock and abutments of the dam, but this was finally secured at the last session of the Legislature, through the efforts of the Chamber of Commerce of this city. The purchase of the ground having been completed, the engineers will begin their work shortly, and it was deemed proper to hold the present meeting of the Commission for the purpose of taking steps to regulate the construction of the dam, and also to consider what measures should be taken to forward the enterprise. After dwelling at considerable length on the national value of the improvement of the Ohio and its tributaries, the report continues: "After some four years of waiting and working you stand ready to witness the first work in the system of improvement, which will, we trust, in some form or other render the Ohio the great highway, not only of national foreign commerce, but of domestic interchanges. At the present time this domestic commerce of the towns and cities of the Ohio is stated by the Senate Committee on Transportation, at $1,647,000,000, nearly double the whole foreign commerce of the United States.

The opposition of the coal interest to the system of dams adopted, is referred to. The report says that "while that interest is an item in the business of Pittsburgh, of several millions in value, it is but a small portion of the entire coal trade of the district, and yet more so in comparison with the whole coal interests of this city and Western Pennsylvania. It has, no doubt, seemed somewhat singular to you that the abandonment of a system of improvements, endorsed by the best engineering skill of the government, should be insisted upon by the representatives of a mere local trade, when that improvement was called for by a nation, not a district.

The construction of the first dam will determine whether the system now proposed will be continued throughout the Ohio, but the Commission think it likely that other methods will have to be adopted below the falls of the Ohio. Expedition in the construction of the Davis Island Dam is urged, the commission in the meantime to examine other methods

On the subject of appropriations by Congress the report says: "It would seem that the most effective work the Commission can now perform is to urge Congress to make ample appropriations; to this end the combined influence of the seven States should be brought to bear, through their people and their Legislatures. It was only by active measures in this direction that the primary appropriations were obtained. The claim of the Ohio States to disbursements and large ones from the Government, for this improvement is broad and strong. From 1863 to 1873 these seven States paid six hundred and thirty-three millions five hundred and fifty-two thousand and five hundred dollars, or thirty-seven and a half per cent. of all the internal revenue collected in the United States. From 1870 to 1873 these same States paid forty-one per cent. of the entire amount collected. In a period of eight years, from 1865 to 1873, Congress appropriated forty-five millions for improvements of rivers, harbors and forts on the sea-coast. Fifteen millions of that Wisconsin, Michigan, and the lake shore of Illinois and Ohio had, while in a period of fifty years but three millions have been appropriated to the improvement of the Ohio. Contributing the largest proportion of the national revenues, the seven Ohio States receive but a small item of re-expenditure.—*Saward's Coal Trade Journal*, xiv.

The Forging and Tempering of iron or steel can be greatly enhanced, according to Herr. Edward Blass, of Cleve, Prussia, by dipping the metal, in whatever form, in fused salt. This dipping in salt is also well adapted for annealing steel without the oxidation of the surface. If the metal be rusted, it must be allowed to remain some time in the bath. Borax can with good effect be mixed with the salt. Metal "purified" by means of such an immersion is very susceptible to galvanic depositions, and can easily be coated with copper, zinc, tin, nickel, silver, &c.

For iron in the spongy or powdered state, as obtained from the reduction of the ores, the salt bath is especially adapted, for it augments the combination of the particles by making their surfaces free from impurities. To prepare the bath for an application as here proposed, the salt must be fused in a puddling furnace, and the iron sponge, with the addition of a flux, be added in small quantities so as not to vitrify the salt. The iron is left in the furnace till the flux has combined with all the impurities and formed a slag, whereupon the iron is taken out and forged together. While the iron is in the furnace it should be constantly covered with the salt so that oxidation be prevented.

For the hardening of iron, the salt is fused in a convenient vessel and the object immersed, and from time to time a small quantity of ferro cyanide of potassa added, one or two pounds per 100 pounds of iron. The articles, according to their thickness, are permitted to remain from five to thirty minutes in this bath, and are then plunged in water containing in 100 parts, one part of hydrochloric acid, five of wine vinegar, and one of salt. If the objects are to have a silver lustre, they should be immersed for a few minutes in a mixture of three parts wine vinegar and one of hydrochloric acid.—*Maschinen Constructeur*, x, 399.

The Mississippi Jetties.—Capt. J. B. Eads publishes a paper replying to the adverse criticisms on the Mississippi jetties. He affirms that there has been no shoaling, as charged, and that on the contrary, there has been considerable deepening of the gulf over several hundred acres outward from the end of the jetties between diverging lines. In short, Capt. Eads claims that the jetties are just the success they were promised to be.—*Am. Manuf.*

MINING, METALLURGY AND MINERALOGY.

How Hot it is in a Deep Mine.—The Virginia *Enterprise* remarks that those who have never personally inspected the lower levels of our mines may obtain some idea of the degree of heat to be found therein by visiting the Savage works at the change of shifts. The men—packed together as close as they can stand on the cage—are popped up out of the shaft all steaming hot, for all the world like a bunch of asparagus just lifted from the pot. They make their appearance in a cloud of steam that pours up continuously from the "depths profound," and are dimly seen until they step forth upon the floor of the works. As the men land and separate, each carries with him for half a minute his little cloud of vapor. As this passes off the man is seen to be naked from the waste up, his skin as wet as though he had just been lifted out of a pool of water. The men bring up with them—besides the steam—an amount of heat that may be felt by the spectator as they pass. All this is at the top of the shaft, where it is considered quite cool—what then, must it be hundreds of feet below, where the men started from—down where the water stands 157 degrees Fahrenheit? Down there no steam is seen—it is too hot for it. It is only when the hot, moist air coming up from the lower regions strikes the cool air towards the top of the shaft that it takes the form of steam. Down there where the men come from you must keep your hand off the pump column and the pipes, and if you pick up any iron tool you will at once put it down without being told to do so. Down there they handle things with gloves on or wrap rags around the drills they are guiding and iron apparatus they are moving, and, down there, too, you will learn to keep your mouth shut after you have drawn a few mouthfuls of hot air into your lungs. Perspire? It is no name for it. You are like a sponge that is being squeezed. You are ready to believe that you have ten million pores to every square inch of surface, or as many more as any authority may mention, and that these pores are as big as the cells of a boney-comb. You go for ice water, and it almost seeems to hiss as it passes down your throat; you keep going for it, and thus, in a short time, find out what becomes of the tons and tons of ice that are daily consumed in the mines. Remain below among the miners for an hour or two, and when you are finally popped out at the top of the shaft, all red hot and steaming, among the other asparagus sprouts, you will appreciate the beauty, the light and the coolness of the upper world.

—A three foot vein of coal has been discovered in Union township, Crawford county, Pa.

MISCELLANEOUS.

The Origin of Organic Beings.—Two explanations have been introduced to account for the origin of the assemblage of organic beings, plant and animal, that surround us. These are conveniently designated as the hypothesis of Creation and that of Evolution.

The hypothesis of Creation asserts that Almighty God called into sudden existence, according to his good pleasure, the different types of life that we see. This hypothesis has an ecclesiastical form, that the world, with all its various animals and plants, was created about six thousand years ago. The work was completed in six days, and was perfect, needing no improvement. At the close of each day the Almighty surveyed what He had done, and pronounced it very good. He brought all the animals thus made before Adam in the Garden of Eden to receive their names. There was nothing more necessary, and on the seventh day He rested.

The hypothesis of Evolution asserts that from one or a few original organisms all those that we see have been derived, by a process of evolving or development. It will not admit that there has been any intervention of the divine power.

The former of these hypothesis considers each species as independent of all the others; the second consider them as inter-related. Creation reposes on the arbitrary act of God; Evolution on the universal reign of law.

The hypothesis of Evolution in its scientific form presents three factors: 1. Heredity; 2. Environment; 3. Adaptation. By heredity is meant the tendency manifested by an organism to develop in the likeness of its pregenitor. By environment, the sum total of the physical conditions by which the developing organism is surrounded—the ambient world. By adaptation, the disposition so to modify as to bring an organism and its environment into harmony. This may be accomplished either by progression or retrogression.

As to the origin of organisms, it withholds, for the present, any definite expression. There are, however, many naturalists who incline to believe in spontaneous generation. In its most improved form it occupies itself with two classes of problems, the direct and the inverse, considering in the former the effect of the environment on the organism, and in the latter deducing from the organism the nature of the environment. Thus Schleiden gathers from the structure of the stems of certain pine trees, the distribution of climates at the time of their growth; and the ancient geographical connections of Madagascar and of Australia may be thus ascertained from their fauna.—*Dr. Draper, in "Evolution," on Popular Science Monthly for December.*

A New Safety Dynamite.—An improved nitro-glycerine compound has been invented. Mr. Gustaf Fahnehjelm, of Stockholm, the chief modification being that the second main ingredient is charcoal produced from a special wood, and selected and prepared in such manner as to be able to absorb and solidify the greatest possible quantity of nitro-glycerine. In order to render the combustion more complete, and to augment the rapidity of the explosion, a small quantity of nitrate of potash or other suitable salt, is added to the mixture of the two ingredients above named. The composition of the new sebastin depends upon the objects for which it is to be used, and the effects intended to be produced The strongest compound, and even in this there is stated to be no risk of the separation of the nitro-glycerine, is composed of seventy-eight parts by weight of nitro-glycerine, fourteen of the wood charcoal, and eight of nitrate of potassa; and when less power is required the proportions are varied, the second quality consisting of sixty-eight per cent., by weight, of nitro glycerine, twenty of charcoal, and twelve of nitrate of potassa.—*Saward's Coal Trade Journal*, xiv.

To Remove Foreign Bodies From the Throat, such as pieces of meat. etc., Dr. Beveridge, an English naval surgeon, recommends the plan of blowing forcibly into the ear, as a simple and effective mode of relief. This is affirmed to produce powerful reflex action, during which the foreign substance is expelled from the trachea.

—The N. & G. Taylor Co., Limited, Phila., have the largest single sheet of tin ever made (144×48 inches).

The Social Organization of Ants.—Let us suppose that, having no previous acquaintance with the subject, we were suddenly informed, on good authority, that there existed in some part of the globe a race of beings who lived in domed habitations, aggregated together so as to form vast and populous cities; that they exercised jurisdiction over the adjoining territory, laid out regular roads, executed tunnels underneath the beds of rivers, stationed guards at the entrance of their towns, carefully removed any offensive matter, maintained a rural police, organized extensive hunting-expeditions, at times even waged war upon neighboring communities, took prisoners and reduced them to a state of slavery; that they not merely stored up provisions with due care, to avoid their decomposition by damp and fermentation, but that they kept cattle, and in some cases even cultivated the soil and gathered in the harvest. We should unquestionably regard these creatures as human beings who had made no small progress in civilization, and should ascribe their actions to reason. If we were then told that they were not men, and they were in some places formidable enemies to man, and had even by their continued molestations caused certain villages to be forsaken by all human occupants, our interest would be mixed perhaps with some little shade of anxiety lest we were here confronted by a race who, under certain eventualities, might contest our claim to the sovereignity of the globe. But when we learn that these wonderful creatures are insects some few lines in length, our curiosity is cooled; we are apt, if duly guided by dominant prepossessions, to declare that the social organization of these beings is not civilization, but at most *quasi*-civilization; that their guiding principle is not reason, but "instinct," or *quasi*-intelligence, or some other of those unmeaning words which are so useful when we wish to shut our eyes to the truth. Yet that ants are really, for good or evil, a power in the earth, and that they seriously interfere with the cultivation and development of some of the most productive regions known, is an established fact.—*From "Our Six-footed Rivals," in Popular Science Monthly for December.*

The Quickest Passage on Record between England and Australia.—The *Melbourne Argus*, September 3rd, says:—The fastest passage on record from London to Melbourne has been made by the Lusitania, of the Orient Line. She arrived on the 8th ult., bringing English papers of three weeks' later date than those of the previous mail. The voyage has been performed in 40 days 6½ hours, inclusive of a detention of one day and seven hours at St. Vincent, where a call was made for coal, and the total time the steamer was under way was 38 days 23 hours and 40 minutes. Some very fast steaming was done, and the average speed per day was 311½ miles, the least day's work being 144 miles. The Lusitania brought out 345 passengers, 68 of these being in the saloon. This quick passage of the Lusitania has excited much attention showing, as it has done, that in the matter of steam communication, *via* the Cape the colony may be better served by competition than by the subsidy of any particular line. The Lusitania goes home by the Suez Canal, which route has also been chosen for the homeward road of the Whampoa. It is interesting to note that, although the August mail was delivered in Melbourne a week before contract time, the time occupied between London and Melbourne was only one day less than the direct voyage of the Lusitania.

The Extension of Tea Culture.—For a number of years the Department of Agriculture, at Washington, has been trying, without much success, to induce the citizens of our warmer States to undertake the cultivation of tea. The plant has been successfully grown in a number of States. In many parts of the South, and in California, the tea plant thrives quite as well in its native country. In fact, there is no reason to doubt the capacity of the country to produce all the tea required, certainly for home consumption, and thus keep at home the millions annually paid to the tea-growers of China, Japan and other countries where labor is cheap and plentiful. That sort of tea-growing is barred out of our country by the high price of labor. But that does not or need not prevent our raising a large, if not the larger part of the tea we use. Even in China it is the general distribution of the tea-plant, not its wholesale culture, that makes the annual crop so large. The 250,000,000 pounds a year sent to foreign countries is probably not more than one-tenth the amount produced; yet the subordinate part allotted to tea growing is one of the most striking facts noticed by travelers in the tea-producing districts. Large plantations are few, and six or seven hundred weight is a large annual average for an individual farm. But, while a few grow tea on a large scale, every one who has a garden has a few trees that grow in the corner of it. In this way millions of trees grow to make up the bulk of a tea crop without materially effecting the agricultural industry of the country. It is rather a domestic industry left to women and children than an integral part of agriculture; and though of late years tea plantations are increasing in number and importance, no specific enumeration is yet made of tea lands in the revenue returns of the taxable lands of the empire. In like manner, by the general raising of a few shrubs for domestic use by families owning garden plots, a large portion of the 50,000,000 pounds of tea annually consumed in this country might easily be grown on the spot without perceptibly interfering with present garden products or household industries.

Bronze Colors.—The bronzing of cast-iron, wood, gypsum, &c., by means of powdered metallic alloys, can be best accomplished, according to Herr. J. J. Hess, by taking a certain quantity of metallic powder and placing it with a given quantity of sulphuretted hydrogen in a well corked flask, and frequently shaking it. After an action of twenty-four hours the sulphuretted metal is poured on a dense cloth, and the water filtered off. (It is unnecessary to say that this operation should take place in the open air). The powder is then carefully dried in a clean iron or copper vessel, and heated until it assumes the desired color. This heating is a very delicate operation, and the proper temperature can only be learned through experience. The color of the bronze depends on the extent to which the alloy is acted on by the sulphur, and on the composition of the alloy.

In the following table is given the composition of the alloys necessary to produce the different colors.

	Per Cent.		Per Cent.		Per Cent.	
Dark yellow,	82.33	Copper,	16.69	Zinc,	0.16	Iron
Light green,	84.32	"	15.02	"	0.63	"
Lemon,	84.50	"	15.30	"	0.07	"
Copper red,	99.90	"	——	"	——	"
Orange,	98.93	"	0.73	"	——	"
Light yellow,	90.00	"	9.60	"	——	"
Crimson,	98.22	"	0.56	"	0.30	"
English composition	96.46	Tin.	2 39	"	0.56	"

—*D. Ind. Ztg.*, 1877, 415.

French Opinion of Glycerine in Disease.—*The Journal of Chemistry* summarizes M. Catillon's paper on glycerine in therapeutics, read before one of the medical societies of Paris, giving the opinion of eminent professional authorities as to the value of glycerine in therapeutics. It appears from this that Dr. Lauder Lindsay believes the article to have soothing emollient, and even antiseptic properties and a very marked action on assimilation, nutrition, and development. Dr. Davisse also bears testimony to its regenerating action on the digestive functions. Dr. Daude has made use of it in the treatment of dysentery with very favorable results. Dr. Pavy and many other physicians have employed it to overcome the disgust for food experienced by diabetic patients deprived of sugar, and to facilitate digestion. Prof. Fubler has administered it in acne with excellent results; at the same time he noted that the action of the bowels, which had been infrequent and difficult previously, became regular under this treatment, but without diarrhea. Demarquay thinks that glycerine would have good effect on intestinal derangements.—*N. Y. Tribune.*

The Mismanagement of Savings-Banks.—The recent scandalous revelations concerning the management of savings-banks and similar institutions of trust have, of course, provoked much discussion, and, equally of course, much loose talk.

The obvious fact that many of the men who have been chosen, or have assumed to take care of the savings of the frugal have proved to be wholly unworthy shows, it is often argued, an alarming decadence in the moral tone of the community, which is variously ascribed according to political or religious bias. There are not wanting those who assert that the whole social organism is unprecedentedly corrupt, and that the facts which have transpired are but a faint precusor of what is to come. But it is by no means clear that any such doleful view of the situation is warranted. The morals of trade may be loose enough, but it is not readily to be admitted that they are deteriorating.

It is true that the early history of savings-banks in this country shows no such dark picture. Previous to 1862, failures were rare; the banks were, as a rule, safely managed by fit men. A high order of financial or executive ability is not required for the management of a savings-bank, but integrity and common-sense are; the right paths are straight and well beaten—what is needed is a steadiness of purpose to resist the temptations that lead away from them. During the last fifteen years the number of these institutions has largely increased, and the process of natural selection does not seem to have developed safe officials as fast as they were wanted.

Nor is it alone that it has been necessary to put many new and untried men in places of trust. A higher degree of rectitude has been needed to bear the strain imposed by the speculation and recklessness of a period of inflation than was sufficient in the less trying days which preceded this era—this has not always been found. The prudence of any given man or class is not a fixed quantity, it is subject to fluctuations; it is weakened by the spirit of confidence and rashness that always marks a period of rising prices, and strengthened by the heroic treatment of adversity which is sure to come in with the reaction.—*From an Editorial in the Popular Science Monthly for December.*

—The huge granite monolith, supporting the equestrian statue of Peter the Great, at St. Petersburg, was rolled from Finland on cannon balls.

—The Wilington Overflow Basin (L. S. Moore & Co., 40 Olive St., Boston,) is said to obviate the troubles arising from sewer gas, leakage around basin tops, &c.

—The Mass. Inst. of Technology, at Boston, offers a four years' scientific and practical course for chemists, metallurgists, engineers, architects, manufacturers, &c.

MANUFACTURING AND INDUSTRIAL NOTES.

—The Scovill Manufacturing Co., Waterbury, (Conn)., are making a new patented lock-box for post-offices.

—The Lowell (Mass.,) Elastic Web Company, a new organization, are making arrangements to commence the manufacture of elastic goods, principally shoe goring, at Lowell.

—The barrel manufactory of D. W. Janes & Co., Cambridgeport, Mass., is now turning out less than 2,000 barrels per day, or about half of its capacity. The same firm have another and larger factory in St. Louis, Mo.

—Milford's (Mass.,) aggregate annual production of boots and shoes is figured at over three million dollars, the product of twenty-one shops. All the manufactories of the place give employment to an average of nearly 3,000 hands.

—New Londoners (Conn.) have formed a stock company with $20,000 capital, to manufacture the Nichols acid pump and siphon, a glass affair with which acids and volatile liquids may be drawn from carboys with ease and safety.

—The Concord Axle Works, at Fisherville, N. H., D, Arthur Brown & Co., proprietors, are running on full time. though with a reduced number of workmen. The trade in New England is quiet as usual at this time of the year, but orders from Chicago and the West are coming in quite freely. The California and Pacific coast trade is also very good, orders coming from that section at all seasons of the year.—*Am. Manufacturer.*

—A new manufacturing enterprise which is projected in Hartford, is a factory for the production of glass burial caskets. An effort is being made to organize a company for the purpose.

—A Bridgeport man has invented machinery for making band-saw blades, which have hitherto been mostly made by hand in Germany.

—P. Jewell & Sons, of Hartford, are furnishing the leather belting for the manufactory of munitions of war, which the Turk is now about to establish on his own soil. This order includes a large leather belt, thirty inches wide, for the main shaft.

—The American Watch Tool Company, of Waltham, are about to enlarge their working capacity.

—Geo. Crompton, Worcester, has re-set his house boiler with the Jarvis patent setting, and has shut down his loom works this week, to re-set his boiler there in the same way.

—The Abbot Worsted mills, of Graniteville, recently had two Harrison boilers set with the Bryant & Young patent setting. They find, in its use, a daily economy of over fifteen per cent.

—A former New Hampshire man, E. H. Cheney (a brother of President Cheney of Bates College) and of ex-Governor Cheney, of New Hampshire, who has of late years lived much at the South, is quite enthusiastic on the subject of cotton manufacturing in the Southern States, and in a letter to a Lebanon (N. H.) paper says "that cotton manufacturing in New Hampshire has seen its best days. If an old mill burns it will rarely be re-built, for capitalists are not likely to put more money into manufacturing business so far from the raw material and where fuel is so scarce. More mills have been built in Georgia, since the war, than are now in operation in all New Hampshire. They are all paying factories, too. That tells the story, and New Hampshire people may as well look the matter square in the face.—*Com. Bulletin.*

—American Iron Works, Pittsburgh, Pa.,—double turn to full capacity; 2,000 hands at work,

—The Pottstown (Pa.,) Iron Company are shipping nails to South America.

—Pittsburgh (Pa.) Steel Works—running double turn to full capacity.

—Pittsburgh Iron Works—hoop and band iron—double turn to fullest capacity; employing 800 hands.

—McKeesport (Pa.) Iron Works, W. D. Wood & Co.—planished sheet iron—double turn, employing 300 hands. Demand improving.

—National Tube Works, McKeesport (Pa.)—fullest capacity double turn; ab out 1,000 men employed; orders ahead of capacity.

—Wire Mill—Anderson & Passavant's, Pittsburgh (Pa.) wire mill, on the South Side, is running full double turn on steel wire, for the great East river bridge at New York; 80 men at work.

—The Phœnix Iron Company, Phœnixville, (Pa.) have received so many large orders that they are running night and day.

—The Danville (Pa.) Iron Works are to be removed to Pueblo, Colorado., $12,000 in cash and $20,000 in real estate having been given as an inducement.—*Catasauqua Dispatch.*

—The Edge Moor (Del.) Iron Company have just finished what is known as the Rockville bridge, for the Pennsylvania Railroad Company, and have orders for several smaller bridges.

—Mr. W. W. Hanscom, of the Hope Iron Works, San Francisco, has been for three months, and is at present, busy building the engines for the California street railroad in that city. The engines are of 250 horse-power each, vertical. The road is what is called a wire-rope road, the cars being propelled by an endless wire rope traveling in a tube under the street, the rope being driven by the engine through suitable gearing and drums. The cars are attached to the rope by means of a grip attached to the car and extending down into the tube through a slot in the top, the grip being operated from the car. The road has a double steel track, three feet six inches gauge, and will require about twenty thousand feet of rope. The sleepers and frame work of tube are formed of concrete, into a body of which the whole road is set. Intended to be permanent, and the best of the kind in the United States.

[OFFICIAL.]

INDEX OF INVENTIONS,

FOR WHICH

LETTERS PATENT OF THE UNITED STATES WERE GRANTED FOR THE WEEK ENDING

October 30, 1877,

AND EACH BEARING THAT DATE.

Those Marked (r) are Re-issued Patents.

A complete copy of any Patent in the annexed list, including both the specifications and drawings, will be furnished from this office for ONE DOLLAR. In ordering, please state the number and date of the Patent desired, and remit to

WAHL & GRIMSHAW, Publishers,
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	Class No.	No. of Patent.
Advertising device, automatic smoking, A.H. Dean,	54	196,639
Animal trap, J. C. Ambrose	143	196,549
Annunciator, automatic time table, L. Dart	24	196,637
Arithmetic, apparatus for teaching, R. W. Kavanaugh	146	196,583
Baby walker, J. P. Wick	31	196,730
Bale tie, J. W. Petty	7	196,699
Barrel hoop, L. Reed, (re-issue)	40	7,932
Bed bottom, Read and Howell	62	196,701
Bed bottom, spring, J. P. Allison	62	196,618
Billiard bridge, F. E. Doughty	143	196,568
Boiler tube cleaner, W. Dunn	148	196,642
Boot and shoe seam, G. Stribley	16	196,720
Bottle stopper, T. H. Brady	1	196,624
Bottle stopper fastener, W. H. Hicks	1	196,527
Broom rack, S. W. Sheldon	62	196,599
Bung, Guenther and Hoeppner	40	196,659
Bung extractor, W. A. Wiley	40	196,611
Burglar alarms, circuit breaker for electro magnetic, J. J. Bradley	50	196,557
Butter and lard package, J. P. Perkins	45	196,538
Butter mold, A. W. Faris	45	196,573
Cages, fountain cup for animal, O. Lindemann	170	196,684
Canal lock gate, W. L. Marshall	82	196,686
Cane and umbrella, combined, A. Mungle	162	196,592
Car coupling, L. T. Beaver	122	196,622
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Chair, folding, G. McAleer	62	196,688
Chair, folding, G. McAleer	62	196,689
Check rower, M. Newton	133	196,537
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Clock pendulum, A. B. Richmond	36	196,702
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Coffee roaster, A. R. J. Lauger	154	196,681
Coking coal and desulphurizing the coke, L. Stevens	61	196,714
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Corset, J. M. Van Orden	80	196,727
Cuff, E. K. Betts	38	196,555
Cuff, E. K. Betts	38	196,556
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Curtain cord holder, A. S. Dickinson	62	196,567
Door sill, S. M. Stewart	30	196,715
Drawer pull, G. W. Tucker	93	196,606
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Dredging machine, hydraulic, J. B. Eads	82	196,646
Dress elevator, G. Havell	38	196,664
Earth augur, D. G. Fields	51	196,649
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Excavating machine, McMurphy and Chapman	51	196,589
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Feed cooker, C. S. Burns	59	196,628
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Fence post, Chandler and Deering	52	196,561
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Grain binder, E. Dederick	74	196,640
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Grain tally, P. Thomas	159	196,603
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Harrow and cultivator, combined sulky, P. F. Fleming	73	196,523
Harvester, S. and M. Dyer	74	196,570
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Horseshoe, D. W. Copeland	60	196,633
Horseshoe, J. N. Schuldt	60	196,541
Horseshoe nail machine, W. Keys	60	196,585
Hydrant valve, J. W. Rohn	167	196,540
Ice surfaces, producing evenly congealed, J. Gamgee	83	196,653
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Kitchen cabinet, G. P. Ziegler	88	196,736
Ladder and step, combined, J. Lane	30	196,679
Ladder, step, A. Larkin	30	196,680
Lamp, H. L. Ives	90	196,581
Lamp, fishing and wharf, Wilson and Keagle	90	196,613
Lamp fount, E. W. Andree	90	196,551
Lantern, L. G. Huntington	90	196,580
Latch, gate, R. E. Stephens	93	196,718
Lathe chuck, J. Herriot	100	196,525
Lathe for turning paper mill rolls, C. Parent	100	196,593
Lathes, cutter for, J. Du Bois	100	196,644
Leather, sample of, J. Kent	92	196,673
Lighting device, I. M. Rose	90	196,706
Lightning conductor, W. Brown	50	196,518
Liquor shaker and strainer, W. H. Trepus	88	196,605
Loom, E. Oldfield	95	196,694
Loom beddle, J. M. Flagg	95	196,522
Loom stop motion, J. H. Mortimer	95	196,590
Lubricator, G. H. Flower	87	196,650
Match safe, Wright and Hill	90	196,734
Meat cutting device, C. Kieser	26	196,674
Milking stool, O. G. Scriven	45	196,543
Mosquito bar and clothes drier, combined, C. Sundquist	62	196,723
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Neck tie retainer, F. W. Koch	38	196,587
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Oil wells, machine for drilling, J. Stengel	124	196,717
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Ordnance, vent stopper for, P. B. Lawson	105	196,682
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Packing for blower cylinders, piston, T. H. Bourke	152	196,627
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Paper, lining and packing, O. Long	108	196,531
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Paper, machine for the manufacture of thick, D. Scrymgeour	108	196,542
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Photographic camera, J. C. Moss	111	196,591
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Piano hammer, G. C. Smith	112	196,712
Planter, corn, A. O. Abbott	133	196,616
Planter, corn, L. Defenbaugh	133	196,641
Planter, walking, J. M. Brown	133	196,517
Planters, attachment for corn, R. Wagoner, Jr	133	196,728
Plaster of Paris, process of hardening, A. B. and R. A. Kay	115	196,671
Plow, gang, W. Fruhling, (re-issue)	114	7,931
Pulverizer, soil, J. Adams	73	196,617
Pump for fire service, W. Jeffers	118	196,669
Pump, osciliating, G. R. Winkler	118	196,732
Punching or shearing, machine for, Gooder and Lavin	119	196,576
Railroad frog, G. W. Billings, (re-issue)	120	7,929
Railroad rail joint, W. G. Dunn	120	196,569
Railway switch signal, G. W. Anders	120	196,619
Refrigerating medium, J. Gamgee	58	196,654
Refrigerator, J. A. Kunkel	58	196,675
Rock drill, W. W. Gaines	124	196,574
Rudder chuck for vessels, C. M. Tarr	137	196,602
Safe, fire and burglar proof, Urban and Berkmyer	128	196,608
Safe, fire proof, H. Urban	128	196,725
Sash fastener, F. Caspar	24	196,630
Sash fastener, A. Cummings	24	196,635
Sash fastener, W. E. Hammond	24	196,662
Sash holder, E. Mead	24	196,690
Sash lift and lock, E. Parker	24	196,697
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Shutter fastening, E. Parker	24	196,696
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Spoon handle, P. Lesson	88	196,683
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Stamp, canceling, A. Daul	146	196,638
Stamp, perforating, W. W. Eaton	146	196,647
Stave sawing machine, Miller and Head	40	196,691
Steam boiler, duplex, J. B. Rivera	148	196,597
Steam generator, T. F. Butterfield	148	196,559
Steering apparatus for vessels, steam, F. E. Sickles	137	196,709
Stove and furnace, A. C. Rand	154	196,700
Stove, cooking, B. F. Holbrook	154	196,528
Stove leg fastening, T. H. Roberts	154	196,705
Sucker rod adjuster, W. H. Curtis	118	196,564
Sun dial, A. W. Anderson	36	196,550
Suspender ends, clasp for, G. H. Leonard	23	196,588
Tablet, rolling pocket, H. T. Cushman	146	196,636
Thill coupling, D. R. Silver	31	196,601
Thill couplings, anti-rattling spring for, H. Beard	31	196,556
Tobacco pouch, C. A. and N. T. Spence	160	196,544
Toilet case, Carroll and Lee	161	196,629
Toy bird, C. Robinson	143	196,704
Toy buzz, D. T. Snellbaker	143	196,713
Umbrella runner, A. B. Knapp	162	196,586
Vehicle axle, A. K. Stone	31	196,719
Vehicle axles, splicing bar for, I. Arthur	31	196,620
Vehicle spring brace, M. Newton	31	196,536
Ventilating and other passages, automatic regulator for, H. M. Lane	166	196,678
Vice, Hensen and Osborn	60	196,578
Watch case spring, D. C. Voss	36	196,609
Watches, dial fastening for, L. Van Doren	36	196,726
Water closet, M. Sulzbacher	8	196,721
Well boring apparatus, C. B. Hewitt	51	196,526
Wind wheel, Lowry and Hunt	118	196,685
Windmill, Gray and Knox	118	196,524
Window screen, J. S. Wilson	30	196,548

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A GUIDE TO THE DETERMINATION OF ROCKS. Being an introduction to Lithology. By Edward Jannitaz. Translated from the French, by Geo. W. Plympton, C. E., A. M., &c., N. York. D. Van Nostrand, publisher, (12 mo. 165 pp.)

This excellent manual for the student of lithology gives a very through description of the crystallographic and other physical characters and chemical behavior of the mineral species entering into the constitution of rock masses; a description of the numerous rock species; and elaborate instructions for the practical determination of rocks. The demand for practical hand books like this is a gratifying indication that the days are gone by when mineralogy and lithology were taught by memorizing.

PUBLICATIONS RECEIVED.

GEOLOGICAL SURVEY OF MISSOURI: Industrial report on lead, zinc and iron, together with notes on Shannon county and its copper deposits. By Charles P. Williams, Ph. D., acting state geologist. Jefferson City, 1877, 200 pp. 800; from the Author.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA. The following reports: C. CC. D. HH. J. K. L. & M. From Hon. F. A. Osbourne, Phila.

REPORT OF THE SECRETARY OF INTERNAL AFFAIRS, PENNSYLVANIA: Part III—Industrial Statistics, 1876; Part IV—Railroads, Canals and Telegraphs, 1876.

INSURANCE REPORT, Pennsylvania, 1876.

REPORT OF THE BOARD OF PUBLIC CHARITIES, Penna., 1876.

REPORTS OF THE INSPECTORS OF MINES, Pennsylvania, 1876.

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From Hon. F. A. Osbourne, Philadelphia.

QUARTERLY REPORT OF THE CHIEF OF BUREAU OF STATISTICS for showing the Imports and Exports of the United States, for the three months ending June 30, 1877. From Edward Young, Ph. D., Chief of Bureau.

ANNUAL REPORT OF THE CHIEF ENGINEER OF THE WATER DEPARTMENT of the City of Philadelphia for the year 1876. From the Chief Engineer.

DEPARTMENT OF AGRICULTURE REPORTS for the years 1874, 1875 and 1876. From the Commissioner.

THE SANITARY OF THE CITY OF BOSTON; Being the Report of a Medical Commission, appointed by the Board of Health of the city of Boston, to investigate the sanitary condition of the city. Boston, 1875. From the Board of Health.

1ST, 5TH, 6TH & 7TH ANNUAL REPORTS OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS. From the Board.

SEVENTH ANNUAL REPORT OF THE GEOLOGICAL SURVEY OF INDIANA, made during the year 1875. By E. T. Cox, State Geologist. From the Author. (Previously noticed in the REVIEW.)

ANSWERS TO CORRESPONDENTS.

ROLL TURNING. (G. D., Morrisville). There is a work by Tunner, translated by Pearse.

"FRENCH BRONZE." (A. M. S., Toronto). This is spelter (or zinc) run in copper moulds.

THE NEEDLES OF CLEOPATRA. (R. J., Utica). There were five of these monoliths, at On, or Heliopolis.

SLIDE VALVE. (L. L. J., Peoria). (1) The three-ported *D* valve is not the simplest form of slide valve. (2) It need not be worked by an eccentric proper. (3) A slotted cross-head gives the same results as would an infinitely long connecting rod.

"PLUGGING" ELECTROTYPES. (C. H. G., Sterling, Ill). This is more difficult than with wood-cuts or stereotypes, as the copper shell is apt to curl up either in cutting or when on the press.

CORES FOR STATUARY MOULDING. (A. N. B., Pittsburg). The best way is by what the French call *cire perdue*. A rough model is made: this is coated evenly with modelling wax and finished up; a sand mould is made over all, and then the whole is baked, causing the wax to melt and run out and leave a space to be filled with the metal. The statue of Perseus, by the celebrated Benvenuto Cellini, was thus cast.

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, DECEMBER 8, 1877. No. 23.

BOLT CUTTING MACHINES.*

The accompanying cut (Fig. 1) illustrates quite clearly, with its appurtenances, a power bolt cutter, which is especially worthy of note. The chasers are contained in collets, held in holes in the periphery of a revolving cylinder, precisely as in the late type of "turret" or "monitor" lathes, and each in a similar way presented to the bolt as required, there being a spring stop to lock any desired collet in cutting position. This cylinder is mounted on a sliding carriage moved on the ways of the bed by a hand wheel, pinion and rack, thus causing the presentation of the chasers to the revolving bolt. The turret has nine barrels, holding as many sizes and styles of screw dies, or, if desired, hollow mills for pointing, turning the body or squaring the heads of the bolts, which may afterwards be cut without removal or re-chucking.

The chasers in each collet are numbered and replaceable to order, so that if one be injured, the full set need not be replaced. There may be inserted across the face of the cylinder a plate having square or "hex" perforations and swinging as a vise in which to place nuts to be tapped by bringing them up against a suitable revolving tap, held in the universal chuck on the main and central spindle of the machine. This spindle is hollow, so as to accommodate very long bolts, which may be threaded, full length, by removing the collet diametrically opposite that which is cutting.

There is a drum spindle, bearing a three graded cone, and thus permitting the employment of speed and power graded to the size and depth of the thread to be cut. The chasers have their cutting edges, is formed and presented as to chase the thread (as in a screw-cutting lathe), and not "jam it up," as in most pipe-threading machines, and many bolt screwers. The bed is hollow and receives the oil and turnings; the oil drains through a strainer into a receiver, and is used again. The machine is furnished with taps and dies, cutting from $\frac{3}{8}$ to 1 inch. Its weight is 600 lbs., including counter shafts. The apparatus is furnished with the Pratt friction clutch. Altogether, the machine is a very useful, substantial, and neat-working device.

Fig. 2 shows a modification of the same principle for hand tapping and threading, from $\frac{3}{8}$ to 1 inch. It should prove serviceable in mines for setting up heavy machinery, and in mills for repairing purposes, &c. G.

*Made by the Pratt & Whitney Co., Hartford, Conn.

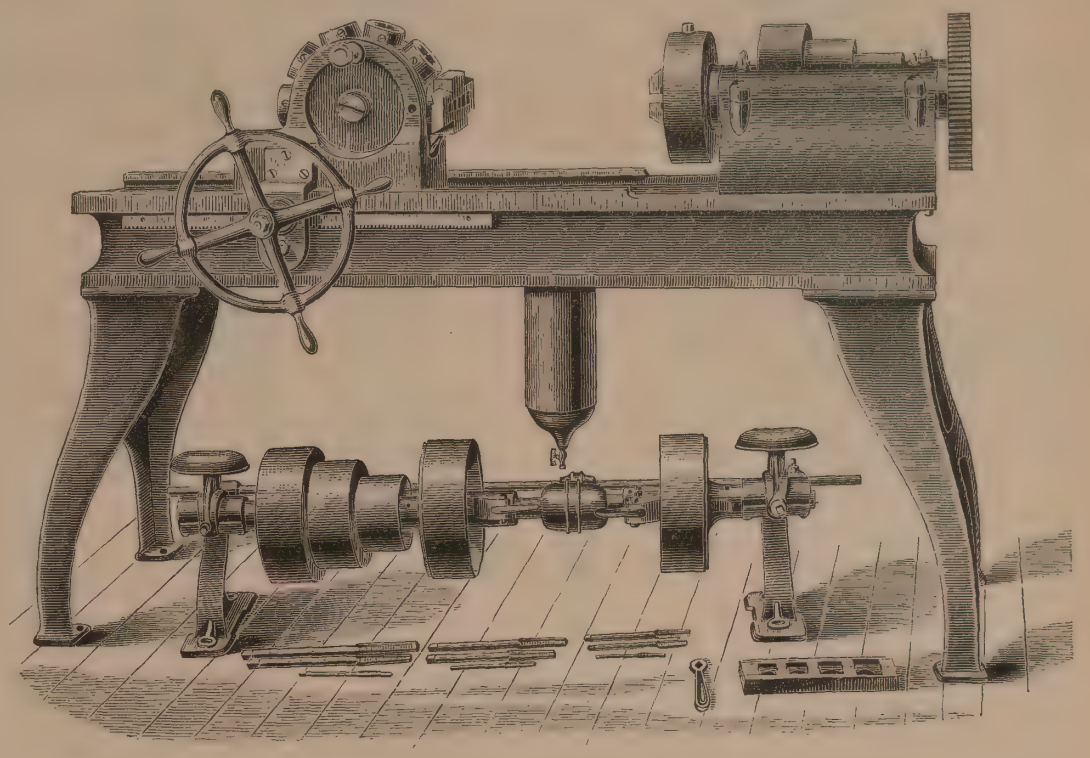


Fig. 1.

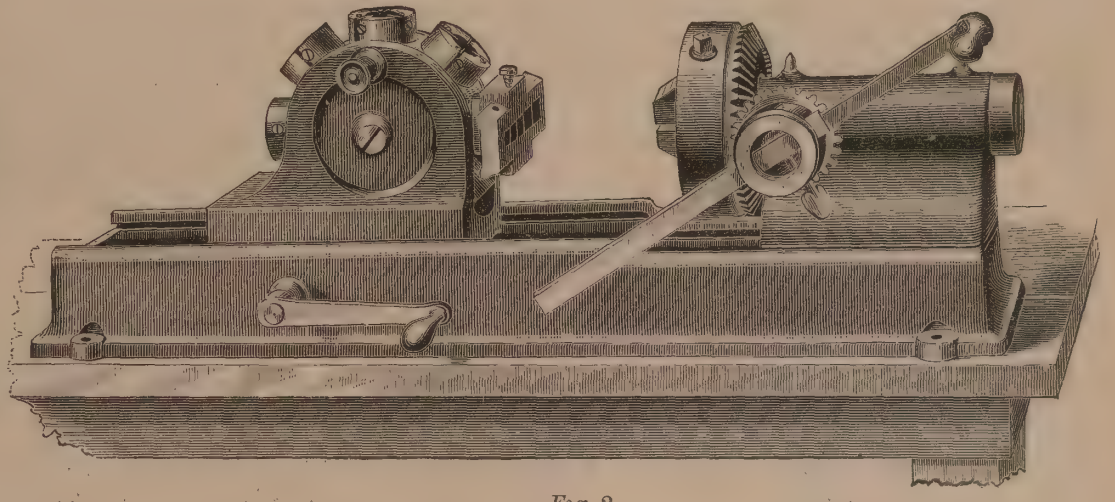


Fig. 2.

* BELTING.

Care of Belts.

In order to have belts run well, they should be perfectly straight and be of equal thickness throughout their length, have but one laced joint; but if circumstances require any belts to be composed of several pieces, the ends should be evenly bevelled, and united by one or other of the permanent ways mentioned hereafter. The ends to be laced should be cut at right angles to the sides, the lace-holes formed by an oval punch, reducing the cross-section of belt the least, and the lacing put in evenly, of equal strength at the edges of the belt, and no crossing of laces on the inside. If copper or other rivets are used, the heads should be "let in" rather below the level of the inside surface of the belt to prevent contact with the pulley, and the washers placed on the outside surface. If the bevelled and lapped ends are sewed, the waxed ends should be "laid in" flush on the inside of the belt to prevent wear.

Belts and pulleys should be kept clean and free from accumulations of dust and grease, and particularly from contact of lubricating oils, some of which permanently injure the leather.

Quick motion belts should be made as straight and as uniform in section and density as possible, and endless if practicable, that is, with permanent joints.

Horizontal, inclined, and long belts give a much better effect than vertical and short ones and those which have the driving side below than otherwise.

Belts which run loose will of course last much longer than those which must be drawn tightly to drive, tightness being evidence of overwork and disproportion.

Tighteners should never be used; but when they must be, they should always be as large in diameter, and as free running as can be, and should be applied to the slack side of belts.

The most effective tightener is the weight of the belt on its slack side, which increases adhesion by increasing circumferential contact with the pulleys.

"Belts which run perpendicularly should be kept tightly strained, and should be of well-stretched leather, as their weight tends to decrease their close contact with the lower pulley.

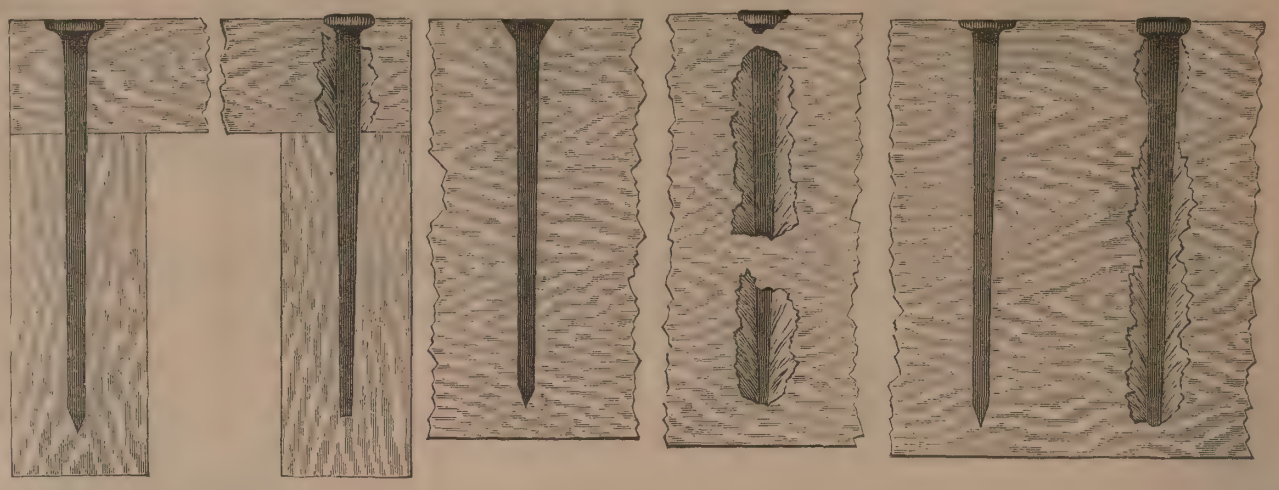
"Belts of *coarse*, *loose* leather will do better service in dry, warm places; for wet or moist situations the *finest* and *firmest* leather should be used

"Care should be taken that belts are kept soft and pliable. The question is often asked: 'What is best for this purpose?' We advise, when the belt is pliable, and only dry and husky, the application of blood-warm tallow; this applied, and dried in by heat of fire or sun, will tend to keep the leather in good working condition; the oil of the tallow passes into the fibre of the leather, serving to soften it, and the stearine is left on the outside to fill the pores and leave a smooth surface.

"The addition of resin to the tallow for belts used in damp or wet places, will be of service and help preserve their strength. Belts which have become hard and dry should have an application of neat's-foot or liver oil, mixed with a small quantity of resin; this prevents the oil from injuring the belt and helps to preserve it. There should not be so much resin as to leave the belt sticky."—*J. B. Hoyt & Co.*

* Extracted from "The Use of Belting," by J. H. Cooper, M. E., (Claxton, Remsen & Haffelfinger, Philadelphia, Publishers.

NAILS.



The most primitive mode of fastening together pieces of wood was doubtless by tying; after which pins of hard wood were used to hold by the friction of their sides against the holes in which they were driven. Later, we find metal nails supplanting in many cases the less satisfactory wood, which, however, still retains its place as the tree-nail or trenail, in frame construction, as buildings, wooden vessels, &c.

The "nail" which Jael, the wife of Heber, drove into the head of Sisera, was a wooden tent-pin. The nails of early Egypt were of bronze; iron nails would hardly have come down to us intact from such antiquity, since their material is perishable by rust.

The Tahitians planted the first nails, which Capt. Cook brought there; thinking them slips of extremely hard wood, desirable to propagate. The invention of the wood-screw for holding purposes gave facility of easy removal and in many cases neater work; while in all cases the fact that the screw compacts and bears against the sides of the hole which it fills, gives it many advantages over the ordinary nail, the action of which is to crowd away the fibres, in most cases rudely tearing or even destroying them.

It must be borne in mind that the nail holds by friction only. The force required to drive one is in some sense a measure of that required to withdraw it; the difference in the case of an ordinary blunt nail being the amount of force requisite to cut and break down the fibres. Hence, greasing which in no ways impairs the holding power of a woodscrew, and facilitates driving or withdrawing it, lessens the holding friction of a nail.

It is only about eight years since all wrought iron nails were forged by hand; Birmingham alone employing 6,000 nailers at the close of the last century. There are said to be 300 varieties now made in England; each in ten sizes. Some kinds (as those for garden-walls, shoe-soles, &c., are cast, annealing markedly improving them.

In 1718, Clarence Dawbeny, patented in England, a process for working iron into "nail rods." In 1790, Clifford, in England, swedged nails between die-rollers; and later employed a bar rolled thinner at the head end; the nails being made in sheets or strips separated by slight fins of metal. Thirty or forty patents followed before the American nail-making machine revolutionized the business. The various process of smelting, puddling, squeezing, rolling, cutting, forging, re-heating and re-rolling the plates, and of cutting and heading the nails at one operation, after heating the nail plate or strip on red-hot coals, may well form the subject of another article—our present intention being simply to describe and note the action in use, of the ordinary nail.

According to their purpose nails are described as hurdle, pail, deck, scupper, sheathing, fencing, slating, &c. The varying shape of the heads divides them into rose, clasp, diamond, billed, countersink, dog, &c. Their points designate them as blunt, flat, sharp, spear, clinch, &c. Their thickness, as fine, bastard and strong. In size they run from one and a half to forty lbs. weight per thousand. Their material gives the varieties of iron, copper, turned, galvanized, &c.; while the mode of manufacture gives them the names wrought, cut, cast, &c. The French employ a pointed nail excellent for some purposes, and made from round wire precisely as pins are made, being in fact simply a large stiff pin, but holding by entirely different means. The sprig, brad, tack, &c., are familiar members of the family; the glazier point (a simple triangle of sheet metal) is never required to resist longitudinally applied force.

Nichols patented a headless nail of sheet iron; corrugation giving it greater stiffness and increased bearing or frictional surface.

Considering the action of driving the ordinary nail, it will be noted that its blunt square point is a rectangle with the greatest length placed across the greatest diameter measured at the head end. In driving into wood easily split, if the head be placed lengthwise of the grain, the point will simply wedge the fibers apart, tending to split the piece. If however, the wedge is placed crosswise of the grain the danger of splitting is lessened, as the blunt edge is crowding the fibers "end-on" and easing the passage of the sides. But if a common ten-penny be driven, ever so carefully at right angles with the grain of soft pine, and the wood be then planed away so as to expose the walls of the hole which has been forced in the material—it will be seen that the fibers are badly ruptured and forced downwards and apart; their ragged ends and the open space between them being illy calculated to give a firm, strong, holding pressure upon the sides of the nail. A more unworkmanlike job than the best driven of our common cut nails, it would be difficult to imagine. If, however, the point be made acute like the pattern-maker's chisel, it cuts the fibers comparatively squarely and cleanly off, instead of tearing them off; the walls of the hole are smooth, and the whole area of the sides of the nail has a bearing surface against which these walls grip firmly; there are no injured or weakened fibres; no vacant air spaces tending to rust the metal.* Such a "chisel pointed nail" is both easier to drive and harder to draw; it is at once highly philosophical and remarkably practical. Smaller sized nails, or fewer of them, may be used; less work is spoiled; fewer nails lost in "flying" or spoiled in driving; the result is more workmanlike and more durable. G.

*The annexed cuts, prepared from actual samples illustrate what we have stated. The difference in the character of the cuts made by the two nails is very clearly seen. The improvement is as radical and important as that of substituting the gimlet point for the old fashioned blunt point on screws. These cuts are kindly loaned us by Messrs. Morris, Wheeler & Co., Philadelphia.

REPORT ON THE LOWE GAS AT MANAYUNK.

BY HENRY WURTZ.

To the Consumers' Gas Company of Jersey City.

GENTLEMEN:—Being requested to make a second visit to Manayunk, and determine the photometric value of the gas now being made there by the Lowe process, I have done so, and beg to report as follows:

A fine photometric apparatus was erected, which was obtained from Mr. W. W. Goodwin, of Philadelphia, with clock-meter, by which the flow could be kept constantly at five cubic feet per hour.

The candles used were also from Mr. Goodwin. They were weighed delicately upon one of my own Becker balances, taken from my laboratory in Manayunk, and with a fine set of Becker's platinum chemical weights, whose accuracy has been verified by myself.

The photometric disc was a new one, of my own making, with square spot, which disappeared absolutely.

On arriving at Manayunk, I found that for the *crude petroleum* (of specific gravity 0.8) used there for enrichment at the time of my former visit, a year ago, (as also at Utica during my investigation of two years ago at that place), there has now been substituted a *light naphtha* of specific gravity 0.706. Desiring to obtain results as nearly as possible comparable with those obtained at Utica, I directed that a somewhat larger proportion of this lighter enriching agent should be used.

This was chiefly on account of the former density of the naphtha, but also partly because the latter contains—weight for weight—about one per cent. less carbon than crude petroleum of average density.

The history of the gas tested and collected for analysis, was as follows:

The generation began at 3 P. M., Oct. 25, and ended at 3 P. M. October 26th. No gas from the coal-benches was being made into the large holder *during* this time.

The total gas generated was 193,000 cubic feet (too large a make, probably, for the small purifiers to carry, even under favorable circumstances.) The amount of anthracite consumed was 9,843 lbs., or 51 lbs. per 1,000 feet of compound gas, or at the rate of 44,000 feet of illuminating gas per long ton (2,240 lbs.) of anthracite.

The amount of naphtha, of 70° was 791 gallons, or 4.1 gallons per 1,000 cubic feet of compound gas, as against 3.15 gallons of crude petroleum of 46°, used at Utica, during my examinations in October, 1875.

This gas was found—as on my previous visit to Manayunk in October, 1876—to be imperfectly purified, staining lead, paper, and precipitating lime-water.

This is due to inadequate tray-surface in the purifying boxes, to withstand the violent though transient, rush of gas from the generators during the rapid stages of its evolution, which causes perforations through the layers of lime, rendering them inefficient for further work.

In my report made of this previous visit—addressed to Mr. Thos. R. Brown, Chief Engineer of the Gas Trust—an improvement in the process was proposed, by introducing, between the condensers and the purifiers, a small holder, to act as a governor.

This has not yet been carried out.

The photometric tests were made upon the gas in the large holder on the 26th of October, between the hours of 12 M., and 3:15 P. M.

They were two in number, and continued during an hour each, the disc being observed at three-minute intervals, or twenty observations during each hour. The mean of all the observations was equal to 20.006 candles burning at the rate of 120 grains of sperm per hour. Had the gas been freed, by complete purification from the two per cent. of carbonic acid which is still retained—as shown by analysis—its candle power would have been at least ten per cent. higher, or twenty-two candles.

It should be added that the burner used was well adapted to the gas, being a 19-candle-27-hole Sugg argand, selected by Mr. Goodwin. The pressure required at this *burner* to pass five feet per hour, was nine-tenths of an inch of water. With inferior burners, doubtless a somewhat lower candle-power might be arrived at.

All of which is respectfully submitted. HENRY WURTZ.

No. 12 Hudson Terrace, HOBOKEN, N. J., Nov. 3rd. 1877.

FORMS OF RIVETS.

Fig. 1 shows a good way to tighten rivet-heads by caulking. Fig. 2 shows good proportions of an ordinary hand-formed rivet, with conical head. Fig. 3 shows a machine-formed rivet, with cup or "snap" head. Fig. 4 is a countersink rivet. For countersink riveting, one diameter in length is enough to form the head, from 1¼ to 1½ being required in ordinary riveting.

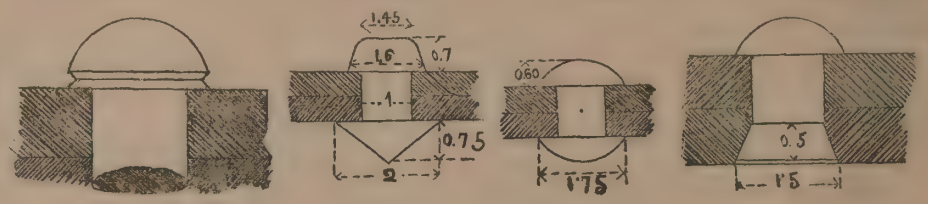


Fig. 1. *Fig.* 2. *Fig.* 3. *Fig.* 4.

THE HANCOCK INSPIRATO R.

The tendency towards simplicity and compactness in construction in many departments of engineering science, is one well worth observing and commending. In boiler feeding, the invention of the "injector" caused a marked advance; direct and continuous impact of the steam being substituted for the same force working upon a piston and driving another piston either upon the same rod or through the intervention of cranks or gearing.

Since the announcement of the discovery of the apparently paradoxical action of a jet of steam, at slightly less than boiler pressure, forcing a jet or current of water against fire or boiler pressure into the boiler from which the steam was taken, the increase in the range and capacity of work of the injector, and in its compactness, convenience and reliability, has been quite marked. Fortunes have been expended in experiments, and improvement after improvement been the result of failures and successes; until now the injector, from being a tricky, unsatisfactory affair, more of a paradoxical toy than a serviceable means of water supply, has become one of the main stays of the engineer for boiler-feeding purposes. As yet, owing in part to the fact that the law of proportion and positions of the jets and passages has not been discovered, but more largely to the fact that most of the work in the steam is expended in raising the temperature of the liquid lifted the duty of the injector as a general liquid elevator, is not yet as near the theoretical point as may be attained by a direct acting or other steam pump. The following figures, given by one of our regular contributors in a recent issue of the POLYTECHNIC REVIEW,* show the duty of the injector as a water raiser:

"Compound pumping engine for water-works, 637,000 foot pounds per pound of coal.

Feed pump on steam engines, 400,000 to 450,000 foot pounds.

Injector, about 67,500 lbs.

Donkey feed pump, 100,000 to 150,000 foot pounds.

It will thus be seen that as an instrument for lifting water, the duty of the injector is very low; while as a combined feeder and heater it shows very favorably.

Total heat in one pound of steam of 100 pounds pressure,		1214 units.
Heat remaining after condensation,		86 "
Heat converted into work,	$\frac{7500}{772}=9.715$	
Heat imparted to 30 lbs. feed water, heating in from 50° to 86°,	1080.	
Lost by radiation, etc.,	38.285	
	1128.000	1128. units.

Of course there are many cases where the low cost and great compactness of the injector, and its infrequent use, more than compensate for the low theoretical and practical duty as a water raiser; and where the heating of the water raised is an object, as it is especially in boiler feeding, the injector becomes in most cases preferable, and in all cases excellent as an adjunct, to the donkey pump; and is even used where there is water pressure enough greater than the steam pressure to permit of boiler supply direct from the service-pipes.

At first, injectors gave trouble, from the fact that their height of "lift" (or suction) was limited; they would not lift even moderately heated water; were not prompt in starting; were liable to stick or clog up; required special adjustment for each pressure or lift; the jarring and jolting of a locomotive (going over frogs and switches,) or the rolling and pitching of a vessel, would break the fluid column or jet; they had a multiplicity of parts requiring oiling and attention, and need the use of both hands to operate them. Some of these defects they possessed in common with the donkey or other feed pump; but others were so marked that in many instances (especially in locomotive practice) injectors were removed and replaced by the formerly discarded pumps. In many cases these troubles were caused by imperfect setting: as leaky suctions; connecting the steam jet, instead of with the boiler direct, with a pipe having a cross current or having a low pressure wet steam; giving too great lift or too hot water; piping the overflows too small, etc. Simplification in the parts, perfecl tion in workmanship, and greater experience in proportioning the parts and in observing the proper conditions of operation, have greatly improved the duty of the whole class of injectors, especially as boiler feeders.

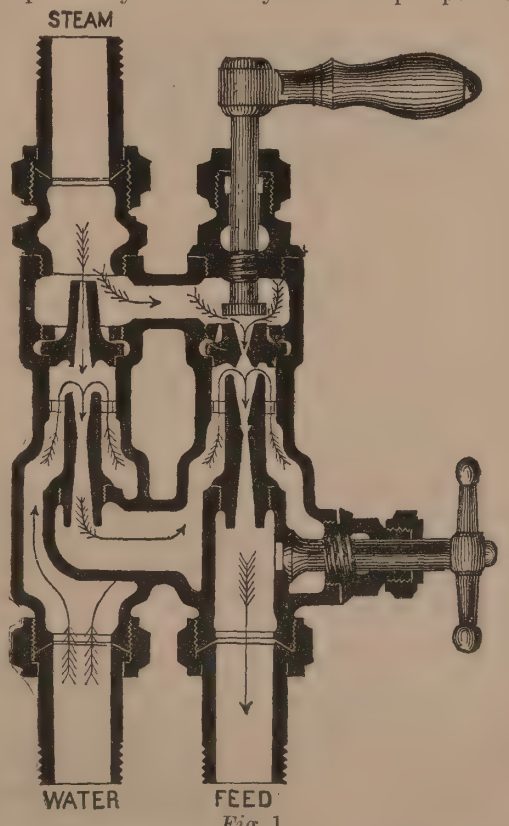


Fig. 1.

One of the most recent and most improved devices growing out of the original and crude invention of Gifford, is the "inspirator"† of Mr. Hancock.

It is shown in longitudinal section in Fig. 1. It consists of two parts, each having a definite function. Connection being made (as indicated by the lettering), with the steam, feed and supply pipes (putting a globe valve at the steam end and a check valve in the feed pipe), the central right-hand valve is opened and the upper right-hand valve closed. Steam entering at the left passes through the left-hand diverging tube, then through the left-hand double-coned pipe. The air in the pipe having been exhausted, the water rises to supply its place, andis carried along with and by the steam; the heated water and condensed steam passing off out of the overflow (shown in Fig. 2). Shutting, then, the central valve (1), the water is compelled to pass up and into the mouth of the right hand double cone; through which last, when the forcing valve (2) is opened and the overflow (3) shut, it is carried directly to the boiler.

It will thus be seen that when the device is working, there are two steam jets, the left-hand one drafting water and delivering it at the proper place for the right-hand one to force it. Fig. 3 shows the same device arranged so as to be operated by a single lever, for locomotive use. The lazy cock may be employed.

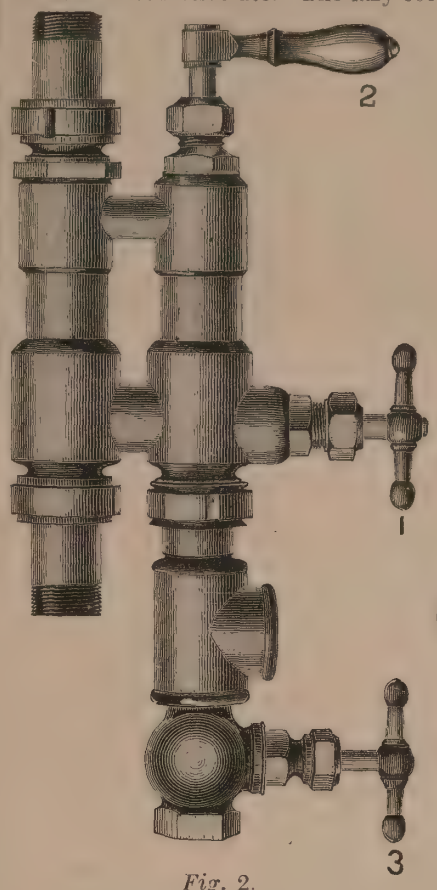


Fig. 2.

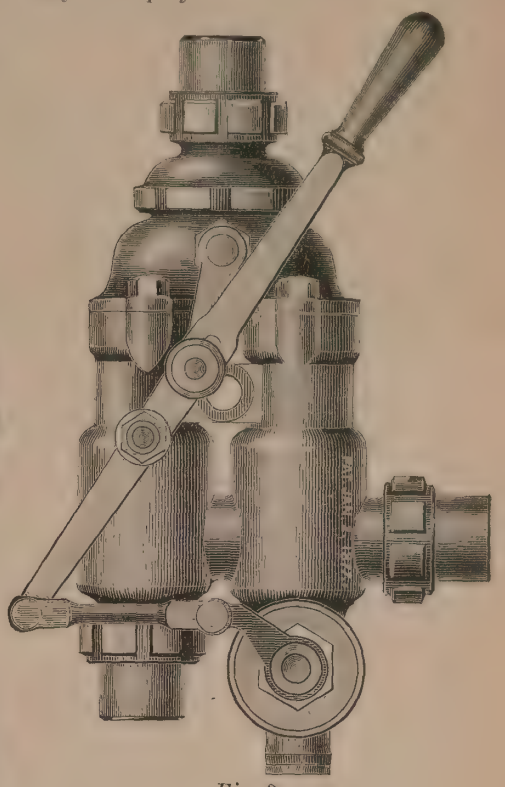


Fig. 3.

As regards the duty of these inspirators, the makers guarantee them to lift water upwards of 25 feet with less than 35 lbs. of steam; to take the water at 120° F. in a lift of 3 or 4 feet, or under a head; or with a lift of 25 feet from 90° to 100° F.

The heat at which the water is delivered, and its quantity, of course, depends on the steam pressure, the temperature of the water drafted, and the amount of steam used on the *forcer* side. With the temperature of the water at 50° and 60 lbs. steam pressure, with one-quarter turn of the *forcer* handle—the water would be delivered at from 160° to 190° Fah. The temperature would be proportionately higher with the water drafted of a higher temperature, a greater steam pressure and more steam admitted on the forcer side.

To ascertain the size required, when the consumption of fuel is known, "the pounds of coal consumed per hour will be the gallons evaporated per hour." When the grate surface is known, and the draft is natural, "multiply the grate surface in sq. ft. by 9, and when the draft is forced, add 50 per cent. for the gallons evaporated per hour."

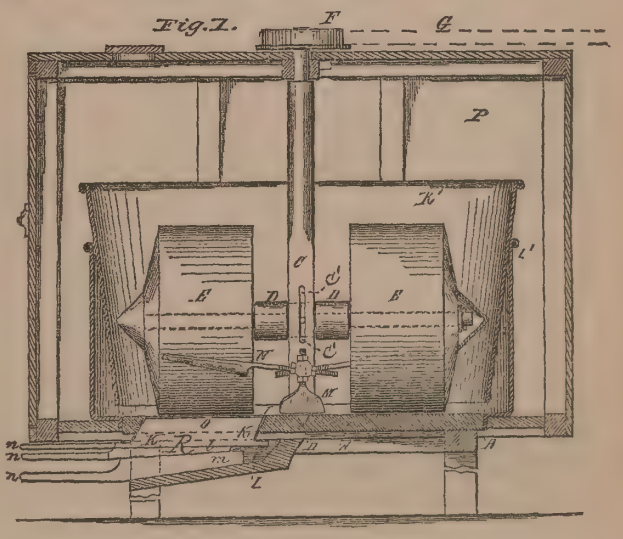
G.

*Mr. J. Haug. Vol. iv, page 79, date, Aug. 18, 1877.

†Invented and patented by Mr. Jno. T. Hancock, Jamaica Plain, Mass. Made by the Hancock Inspirator Co., Ltd.

IMPROVED MILL FOR GRINDING TOBACCO.*

The invention described herewith is intended as an improvement on the mills heretofore in use for the grinding of tobacco for the manufacture of snuff. The apparatus is adapted to the grinding of tobacco both in the dry and wet state, and consists essentially of a frustrum-shaped casing in combination with the casing proper of the apparatus, which is arranged to fit within the same, its lower edge extending to near the bed stone and closely adjoining the track of the chasers so as to collect and return all particles of tobacco too heavy to be carried over its edges during the operation of wet grinding, at the same time leaving sufficient room outside of said track for a full charge of tobacco; secondly, of a discharge aperture through the bed plate, which is closed by means of a detachable plug, which forms a continuous floor with the bed plate and does not interfere with the operation of the chasers.



In the figure the workings are all properly shown. The chaser wheels *E E* being journaled to the shaft *D*, which rests in the vertical standard *C*. *K'* is frustrum-shaped casing referred to. *R* represents the plug for stopping the discharge apertures, composed of three wedged shaped parts *K lim*. The dry tobacco when sufficiently ground is carried over the top of the casing K' and collected in the outer casing. In case of wet-grinding the chasers are revolved until the tobacco is sufficiently comminuted, when the snuff is discharged through the opening in the bed plate.

*Patented by S. V. Appleby, Spotswood, N. J.

THE TRANSMISSION OF POWER BY ROPES OR CORDS.

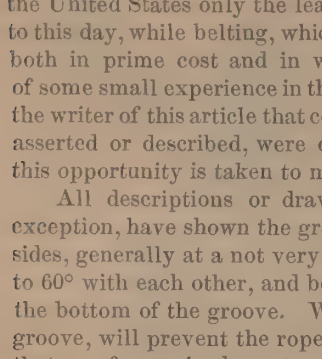
BY ROBERT BRIGGS, C. E.

That this method of conveying motive power has passed beyond the experimental or *inventive* stage in England and Europe, is well known to all observers of foreign mechanical practice or readers of foreign periodical or text-book literature. Nearly twenty years of successful usage and publication being evidence of the facts. But in the United States only the least of application of the method has been accomplished to this day, while belting, which for heavy work or long distance is far more expensive, both in prime cost and in wear, has received a great extension in use. The result of some small experience in the transmission of power by cords, having demonstrated to the writer of this article that certain modifications of detail from what has been generally asserted or described, were desirable, if not essential, for the attainment of success, this opportunity is taken to make them public.

All descriptions or drawings which have been brought to my notice, without exception, have shown the groove of the pulley which carries the rope with deep flared sides, generally at a not very steep angle—the two sides making an angle of, from 40° to 60° with each other, and being three to six diameters of the rope in projection from the bottom of the groove. While this construction certainly, from the depth of the groove, will prevent the rope from riding off from the pulley, yet it can be asserted that, so far as *tendency* to ride off and consequent wear of rope, it is as radically misformed as possible. The rope belongs in its bed in the bottom of the groove, and every mechanic knows if it is *delivered* accurately into that bed as it approaches the pulley, it can only ride out of it by some excess of side friction upon the rope over the stress from the tightness of the rope.

There are three ways of ensuring this accurate delivery. The simplest is a thimble guide. If such a guide is suspended from the axis of the pulley, so that it is free to swing on that axis and present the *axial line* of the thimble to the groove of the pulley wherever the sag of the driving rope may lead it, and the rope can be delivered through a close-fitting hole with the least of friction, then a perfect delivery will have been made. The objection of this way for a continuously running rope, is found in the wear of the inside of the thimble, which is exposed to unremitting friction, no matter how small in amount, and becoming heated, quickly reaches the limit of endurance of material. Even cooling the outside of the thimble will not prevent the increase of heat, and rapid abrasion will ensue. Still, when the power to be transmitted by a rope is a momentary impulse, as in some machines, punches, presses, etc., this means of guiding is preferable to any other. The second way is side pulleys. The objections to these are numerous: first, the arrangement of the pulleys, axes and bearings, in conjunction with the main line shafting, is not convenient, and the axes of the guide pulleys (for horizontal ropes) becomes vertical and difficult to lubricate; second, the guide pulleys, which must necessarily be of small diameter as compared with the main pulleys, must run very fast, and as some freedom must be allowed between the rope and the pulleys on either side, both the side pulsations of the rope and the noise of repeated contact become objectionable; and, third, as the axes of the guide pulleys must have a fixed direction, that direction can only be at right angles with the rope when it has one particular sag, and consequently the *effort* of a guide pulley will be to lead the rope in its plane of movement so long as it bears on the arc of the pulley, and it will jump up or down the face of the guide pulleys, when the next pulsation of contact transfers the rope to bear on the opposite pulley; and, besides this, the general bearing of the rope must be diagonal, either one way or the other, to the faces of the guide pulleys, and an oil-mill grinding friction both on rope and on pulley faces will follow. The guide-pulley way for guiding ropes must be discarded as absolutely impracticable. The third way of ensuring accurate delivery of the rope into its bed in the groove, is to form the guide on the wheel itself. This way is shown by the following illustrations: Fig. 1, section of pulley for wire-rope transmission, and Fig. 2, section of pulley for hemp or cotton rope transmission.

Fig. 1. *Fig.* 2.



It is thought that the practical mechanic will need no further argument to demonstrate that pulleys with flanges formed in this way will infallibly guide the rope to its bed and also become a perfect guard against running off when it is there. The objection to this form of flange is (particularly in the case of the wire rope) the wear of the inside of the edges in the effort to guide the rope. This wear must be admitted, and in lines of rope exposed to the winds it may become serious, so that a guide pulley with a deep flange, or pair of flanges when the groove has no bed (so to speak), may be a necessity to meet the condition, but in ordinary practice inside of a workshop or with moderate length outside of doors, this objection will disappear when the system of shafting is properly lined. The occasional contact with the guiding edge of the flange is the easiest possible. This edge has a *little greater* velocity in the direction of the chord of the arc of contact than the rope has as a tangent to the bed at the root of the flanges, and slides diagonally over the rope in lieu of trying to crowd it out. A new surface of frictional contact with the rope is brought into action each instant, and the rubbed surface has an entire revolution of the pulley to cool in. There is an allowable angle of entrance to the groove as designed in the figures, and if the system is so exposed to the weather as to cause a sidewise deflection from the wind in excess of this angle, the remedy should be sought in side guides of wood to meet occasional blasts, and if the wear on these, or on the rope in coming in contact with them, becomes too great, the necessity of more carrier pulleys is an evident one.

The relation of diameters of carrier pulleys does not seem to me to be fully considered in any publication I have seen. If a system of rope propulsion is made of a single continuous rope of great length with numerous carriers, it follows that the lack of the rope may, and at times certainly will, not distribute itself so as to gives equal deflections between each carrier, and the angle made by the rope on one or the other carrier, on the slack side will become a large one. Under these conditions the carrier should have a large diameter, approximating to that of the driving pulleys about which it makes—properly, a longer angle of contact. If, on the other hand, the propelling rope is made in lengths to call for four to six carriers only, and intermediate drivers are employed for long transmission, the sag will equalize itself when the uniformity of rotation and of work is established and will not unduly accumulate, and then the carriers can be reduced in diameter nearly down to the compatibility of velocity of rotation of the carriers themselves.

The contact of a rope under tension and at considerable speed with a carrier pulley, is not that of a large arc of the pulley, unless such a pulley is so far removed from the next one as to produce a very great catenary arc when at rest. The trajectory of the rope when in motion will give a mere line of touch, on which will be supported the weight and some of the resultant force which proceeds from the carriers standing in opposition to the tangential direction of the trajectory. So far as contact or bearing of rope or carrier pulleys is concerned, where the direction of the motion is not changed, they may have one-half or one-third the diameters of the main pulleys.

The wear of a rope in transmission of power depends on two kinds of friction, the one *external*, from the sliding on the surface of adhesion—the bed of the groove in the pulley—and the other *internal to the rope*, from the sliding of the fibres of the rope on each other in folding around the pulley *under strain*. The former of these is rarely harmful, provided the rope runs in the bed where it belongs. It is the latter principally which wears out a rope. (Of course it is supposed that the rope, if of wire, shall be made of wire so fine that the bending of the metal of each wire in passing over a pulley shall not materially strain or produce heat in the rope.) A half-inch wire rope over a three-foot pulley will demand that the fibres of the rope shall, in twelve inches of length, lay one-third of an inch closer, or shorter in direction of length on the inside than on the outside. This bend is a small one, to be sure; any of our readers can conceive in his mind the form of a twist of single wire for a foot long, as it lays in a rope, and the effect on the metal is insignificant; but when it is recollected that this twist of wire is firmly compacted with other twists, the sliding of each twist on the other must evidently occur under great pressure due to the pull on the rope; and as in the supposed pulley of three feet diameter there are four and a half feet of bend, the sliding cannot be avoided by the yielding of the wires beyond the contact. Hemp and cotton ropes are known to become so hot, from running on small pulleys, that the hand will scarcely bear to hold them, while they nearly always *strand* from internal failure.

There are two distinct kinds of rope propulsion, wire rope and hemp or other fibre or raw hide, the pulleys to carry which demand separate materials and forms. The unyielding wire rope becomes the most effective, as well as the most durable, when in contact with some yielding substance as a bed. India rubber, leather, (hemp or rope) gasket or wood are used to form the bed shown in Fig. 1. Probably the best material is dry pine wood, cut endwise, dried thoroughly after cutting, and squeezed in a vise to give it a temporary compressure to allow it to be set in a dovetail, as shown. The more flexible and yielding ropes require, for adhesion and for the *dispersion of the heat from friction*, metal pulleys of the form shown in the accompanying Fig. 2. The angle of the sides of the groove, as determined by English practice, should be 40°, when a rope on a proper sized pulley will transmit power up to the strain upon it of one fifth or sixth the breaking strain for twelve or fifteen years' service. Fifteen or twenty ropes of two inches diameter have been applied to one main pulley, and 400 to 425 horse-power transmitted for years successfully in this way. Each rope in the case quoted is said to transmit power equal to about a four-inch belt.

In the driving of machines or general transmission of power for shorter distances, such as those now calling for the use of leather belting, in the workshops or factories, there is no call for the flange guides shown on Figs. 1 and 2, and the forms indicated on Figs. 3 and 4 become applicable.

Fig. 3.

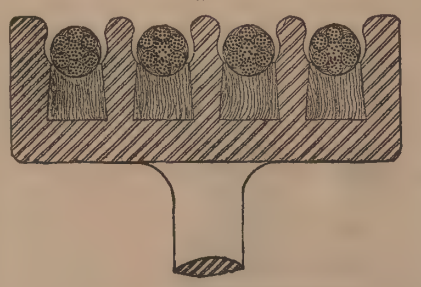
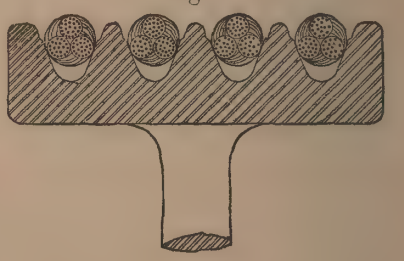


Fig. 4.



There is an evident necessity for side flanges for wire rope, which runs in a bed and has a tendency to mount out of it at any kink of the rope, or whenever the rope slips on the pulley; and an evident propriety of so shaping the flanges that the wire rope will rest against them without tendency to mount—the width of such flanges being increased in case of long transmission, to form entering guides for the rope upon the pulley; while, with ropes of more yielding material, the hold upon the pulley is at the sides of the groove in place of on its bed, as shown by Figs. 2 and 4, and the side flanges can be dispensed with altogether after the rope is once laid in its place; and the deep flange on Fig. 2 is only called for to deliver the rope suitably into its groove, in case of long ropes and rapid transmission; where the vibrations or waves may somtimes cause the rope to sway out of line; and where the trajectory of the rope, from its velocity (centrifugal force modified by the stiffness of the rope), may tend to throw the rope out of the groove, so that slight swaying movement will cause it to ride.

There are no patents on rope propulsion, the whole system having been elaborated, perfected and published years ago in Europe and England; and the sketches of pulleys sent with this, although original, are open to public use.

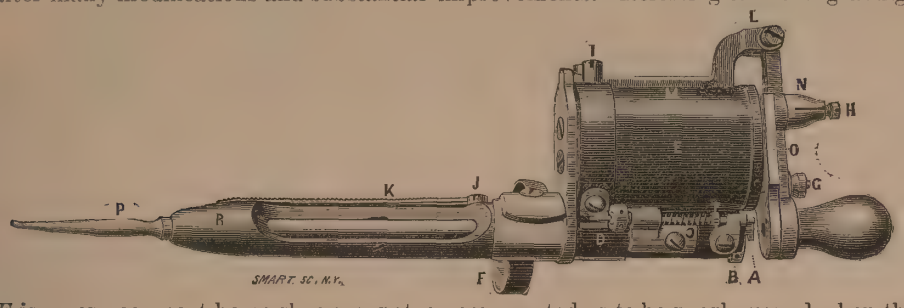
ADULTERATION OF CINNAMON AND PEPPER.

The analyses undertaken by the Berlin police authorities have shown that cinnamon contains on an average about 16 per cent. of mineral matter, principally iron, ochre, and besides a considerable quantity of Indian meal, mixed with the poorest bark, perhaps already employed for the extraction of the oil-of-cassia; so that the whole spice represents but a small quantity of pure material. The examination of pepper showed that about 20 per cent. of it was sand, clay, bone-dust, and even wood. The adulteration of pepper by means of the meal of palm seed is so universal as scarce to deserve mention.—*D. Ind. Ztg.*, 1877, 428.

THE ELECTRO-MAGNETIC MALLET FOR FILLING TEETH.

The duties that have been saddled upon that protean agent, electricity, have been so manifold and extraordinary that nothing that is asserted of, or attempted with it is marvelous enough to attract more than transient surprise, and none are so bold as to venture the word "impossible" in connection with any new demand upon its capabilities whoever novel or unheard of. For proof of these comments, the following brief account of the remarkable apparatus of Dr. Bonwill that heads this notice, will suffice. As its name indicates, it is a dentist's mallet, for filling the cavities of teeth, that is actuated with extreme celerity and precision by means of electricity, relieving the operator of the most laborious and difficult portion of his work, and performing it better, with more certainty, and with vastly more dispatch than by the comparatively crude and laborious methods still in general use.

The invention, though not altogether new, will doubtless prove to be so to many of our readers, and our illustration and description presents the apparatus in its latest form, after many modifications and substantial improvements. Referring to the engraving,



E is a very compact horse-shoe magnet, so constructed as to be nearly round, when the two helices are united. *O* is the armature with a half ounce hammer at the end, over the head of the tool *A*. This hammer is hung upon steel points *L* of the frame, *M*, which frame is continued over to the hard rubber handle *R* through which the tool *P* passes and revolves. The handle is cut out on one side to allow the thumb to come in contact with the tool, and thus enable the operator to rotate it to any desired position, and secure the desired angle for the point of the tool. *F* is a ring through which the right index finger of the operator is passed, so that it may press and rest on the slide *K*, which when pushed forward completes the circuit and makes the blow *T* is an eccentric screw, by which the amount of movement of slide *K* necessary to make circuit may be adjusted to suit the delicacy of touch of each operator. The amount of this movement can thus be gauged from the sixteenth of an inch to a mere trifle. *I* represents the parts to which the wires from the battery are attached. Inside of *N* is a conical spiral spring, resting on the top of the magnet, the purpose of which is to throw the armature back against the check-nut *G*. This last, therefore, in regulating the distance through which the armature travels before striking the end of the tool, controls also the force of the blow. *H* is a screw, designed to increase or decrease the tension of the spiral spring inside of *N*. *B* is the head of a screw which fits into a shoulder on tool *P*, and which by turning up or down, regulates the distance of the tool, to admit of being struck by the hammer. *T* represents an automatic brake, furnished with a spiral spring around its entire length, to draw it back against screw *D*, after the hammer has driven it from its downward blow away from screw *D*. The nut *C* is designed to make the spiral spring in the brake stronger or weaker, causing the armature to give a greater or less number of blows per minute.

The tool *P* is held in position by a flat spring on the opposite side of the mallet in the cut, and pressing on the tool (near *A*) keeps it always up to its highest point against *A*, ready to receive the impact of the hammer. Any desired number of blows, from 500 to 300, per minute, can be made by the slight turning of the screw before referred to.

The effectiveness of the instrument depends largely upon the automatic brake and its related mechanism. The tool may be removed without difficulty, and another substituted.

The apparatus is operated by means of three small cells of a Bünsen battery. These require renewal about once a week, which entails a cost of about fifteen cents for maintenance. In operating it is held in the right hand with the index finger through the ring *F* which enables the apparatus to be held and managed with great ease. The gold is picked up on the point of the tool *P*, and carried at once to the cavity to be filled, when a slight forward pressure in slide *K* causes a series of rapidly repeated blows to be given until *K* is released, on which it returns of itself to its former position breaking the circuit and checking the blows. So long, therefore, as the slide is held forward, the blows are continued with the same rapidity and the same intensity of impact. The arrangement of the brake is such that the full force of the mallet is brought out, and each blow delivered, is an instantaneous "dead stroke."

The circuit is broken just a trifle before the hammer strikes the tool, and the force of the blow at this point is such as to drive the armature far beyond the point struck, giving full time for the hammer to return before the circuit is again closed. The graduation of tool at *A* is so fine that it gets the whole power of the magnet, its distance above the level of the latter being only about $\frac{1}{50}$ of an inch. This also prevents any recoil and gives great steadiness in operation.

The weight of this apparatus as originally constructed was sixteen ounces, but in the course of repeated improvements made upon it, by its inventor, this objection has been obviated, the instrument now weighing but six ounces. Its adjustment is so delicate that its employment is attended with no inconvenience, and its performance is vastly in advance of the old-time hand-mallet work, which it must, in time, wholly replace, for we believe the opinion is very generally entertained by the leading members of the dental profession that this most ingenious apparatus is destined to work a revolution in the practice of an art which owes to American mechanical skill much of the admirable refinement to which it has of late been brought.

We give, in what follows an account of the capabilities of the device from the descriptive circulars of the inventor, * which will afford a proper comprehension of its utility. "It is very little more labor than handling a pen or pencil. Performs in one hour what formerly took from two to four hours by the old hand process, or the hand mallet. The blows are given at the rate of five hundred to two thousand per minute, each blow being effective and under the perfect control of the index finger of the right hand of the operator. The blows are given in such rapid succession that it is impossible for the patient to distinguish each individual blow. The sharp, quick, rapid, lightning-like blows impact at least one-sixth more gold into a cavity than any other process. Teeth too delicate and frail to bear hand pressure, can be filled with impunity with this. The perfect regularity of the blow, being ever the same in intensity, so familiar izes patients with it as to enlist their perfect confidence. No fear of breaking an instrument is ever entertained, as no pressure in the least is exerted. No slipping of the instrument and wounding the adjacent parts can be possible with any kind of care. To some it is unpleasant, as is the case in nearly every practice pursued. As to perfection of filling, when used with even ordinary intelligence, it performs operations in this line that, for compactness, durability and beauty cannot be excelled, nor, in many cases, approached. To patients it is a satisfaction to know that they will get out of the dentist's hands from an operation in one-half to three-fourths less time, and while in the chair there are no forebodings as to any mishap occurring, but a sense of comparative composure. They have further assurance that so far as placing the gold in the tooth is concerned, the operation is so simple that one who cannot put in a good gold filling by hand or other process, is able with this to compete with the best operators in the land.

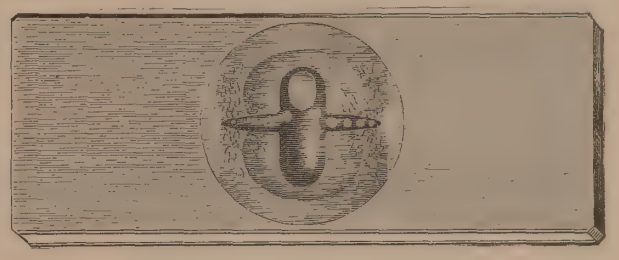
W.

* Dr. W. G. A. Bonwill, of 1722 Walnut Street, Philadelphia.

HOLMAN'S LIFE SLIDE FOR THE MICROSCOPE.†

In the use of the microscope in that branch of science called biology, it is often desirable to keep under view small organisms, such as bacteria and vibriones, for hours, and even for days and weeks at a time. Hitherto this has not been possible, for lack of a proper contrivance; the animals would soon die from the exhaustion of oxygen in the confined space, and they were not in that normal condition necessary for satisfactory study during the time that they did live.

Below is pictured what is known as Holman's Life Slide, which obviates this difficulty. The construction of this accessory to the microscope may be described as follows: In the centre of one face of a strip of glass 3 inches long $1\frac{1}{16}$ inches wide, and $\frac{3}{16}$ of an inch thick, are ground two very shallow cavities, side by side, oval in form, and with their length in the direction of the length of the slide; a straight shallow groove extends between, and a little beyond them at each end; through the centre of these cavities, and at right angles to their long diameter, but not so long as to reach their slides, a cavity is ground as deep as the thickness of the glass will permit.



The cavities and groove thus described, occupy a circular surface of the slide about $\frac{3}{4}$ of an inch in diameter, which is covered, when in use, with a circular piece of microscopic glass 1 inch in diameter.

The philosophy of its action may be thus described: Into the deep cavity, as a reservoir, is put the material in which are the organisms to be examined; the cover is then put on, and the fluid on the surface of the plate wiped away. The pressure of the atmosphere holds the thin cover firmly to the plate, and the fluid between the cover and the plate commences to evaporate at the edges, its place being supplied by more fluid from the reservoir. As the evaporation proceeds, the cover is bent downwards by the atmospheric pressure, and meets a resistance at the junction of the groove with the edge of the shallow cavities, resulting in the edges of the cover rising at each end of the long groove, and a small bubble of air finds its way through the groove to the reservoir. This automatic action thus furnishes a continual supply of fresh air, and the life of the little animals is sustained during the time necessary to observe the changes that take place in them during their life history. When the smaller forms are inclosed in one of these life slides, to get access to the air, they seek the edges of the cover, and range themselves in a zone, at a short distance from its rim, close to where the air comes in contact with the water. Being thus situated, in accordance with the law that compels them to take up these positions, they can be viewed with the highest powers of the microscope, and their true nature and habits much better studied than by the old methods.

D. S. H.

† From the *Journal of the Franklin Institute.*

ELECTROTYPING.

The art of electrotyping, which has grown to be indispensible to the printer and publisher, is popularly believed to be an extremely simple operation, requiring, at most, a little manual dexterity and some little familiarity with the use of the battery. Like many popular impressions, however, this one is very far from the truth. The successful practice of electrotyping demands, not only great manual skill and careful attention to the successive steps of the operation, and to the quality of materials employed, but the number and variety of operations required to produce a finished electrotype block, ready for the printing press, from a form of type (or letter), are such as may surprise even the tolerably well informed.

The notes taken in a tour of inspection through one of the most completely equipped establishments of its kind in Philadelphia‡ have supplied the material for the following description of the electrotyping process, as conducted "with all the modern improvements."

The first step in the operation is the preparation of the matrix, which is to receive the impression of the object to be copied. For this purpose there is provided a "case", a rectangular plate of brass or stereotype metal, provided or cast with a frame or rim around it about ½ of an inch or more in height. These cases are varied in dimensions, according to the size of the subjects to be copied; their average size, however is about 12×18 inches. The case here described is placed upon a table leveled up true, and

‡ Messrs. Mumford & Hanson, 704, Sansom St. Philadelphia.

the moulding composition—a mixture of melted wax and rosin—(or other substance to give it additional hardness)—is ladled from a pot in which it is kept melted, into the hollow space, bounded by the raised frame about the case. The case being slowly filled with as much of the melted wax as it will hold, and any air bubbles appearing on the surface being removed with a heated iron, it is allowed to set or harden, and affords a smooth and even surface. This surface is then dusted with graphite, to prevent the adhesion of the wax to the type in moulding, and is then ready to receive the mould or impression of the type or engraving to be copied.

The operation of moulding, which requires to be done with great care, is performed in what is known as the "moulding press." (See Fig. 1 of plate.) The case is properly "locked up" upon the upper plate of the press, and the letter, engraving, &c. to be copied, rests upon the lower plate or platen. When all is ready, the upper plate, holding the case as before described, is turned down and firmly secured by a massive bar, that engages with projections upon it, leaving the wax surface only a fraction of an inch from the type surface below it; a hand wheel and screw, actuating a double toggle joint connected with the platen, raises this last slowly against the exposed wax surface of the case, and after a few seconds of contact, it is released by reversing the motion. The upper plate is then thrown back, the impression (a reverse of the type, of course) in the wax is inspected, and, if satisfactory, the mould is finished. (Hydraulic power presses, Fig. 2, on the same principle as the one here described, are in use in certain establishments.)

The mould, as it comes from the moulding press, is passed to a workman, in whose hands it is "built up," with a broad chisel-like instrument, having a knife edge; he rapidly cuts away the raised edges that have been forced up about the borders of the case by the press, and which, if not removed, would overlap and hold the copper shell, and make it difficult to remove it from contact with the mould, when it comes from the battery; and then taking from a rack in a small gas furnace, where it has been laid to be properly heated, a small tool, resembling somewhat a soldering iron, with the difference that it curves slightly downward, and tapers off slenderly to a point, he proceeds with the tool in one hand and a rod of wax in the other, touching the hot iron from time to time, to "build up", with the melted wax that runs down the iron, the large open space and other portions of the mould that are not required to give an impression in the printing press. Fig. 3 shows the tool that is usually employed for this purpose. This operation is very essential in order to avoid the "routing" (or deepening of open spaces) which would otherwise be necessary to perform upon the finished electrotype, inasmuch as unless these open spaces are not considerably lower than the level of the spaces between the fine lines of the subject, they are liable to smut in the printing press.

To cut these out with the routing machine, or by hand, from the finished electrotype would be a difficult and dangerous operation; difficult, because of the hardness of the copper surface, and dangerous, because the breaking of its continuity will be likely to cause the curling up of the copper on the edge of the cut, or to loosen its attachment to the stereotype metal, with which it is backed up.

The building up, therefore, of a ridge of wax upon such parts of the mould as require to be depressed in the copper plate, avoids these objections.

When the case is properly "built up" it is again (and this time thickly) dusted with graphite, and placed in a contrivance called a "dusting machine," in which the graphite is thoroughly and uniformly brushed into every space, crevice, and line of the mould. The machine used for this purpose was designed by Mr. Charles H. Hanson, and is quite ingenious, and deserving a description in detail.

It consists of a closed cylindrical chamber of sheet metal, placed upright, and capped with a conical top. The apparatus stands about 6 ft. in height, and is some 2½ feet in diameter. About one third the distance from the top of the chamber, at such a height as to be convenient of access by a door, is a circular plate of cast-iron, supported in a horizontal position, upon a pivot or bearing, which permits it to rotate in a horizontal plane.

The diameter of this plate is but a trifle less than that of the cylindrical chamber. It (the plate) is provided with screw-gearing upon its periphery, which, engaging with a worm, suitably attached, and driven by a pulley and belts, may be set in rapid rotation.

In the chamber, just above the rotating plate, is suspended a set of soft hair brushes, to which a swinging motion is imparted by a crank and connecting rods, operated from the pulley shaft that rotates the plate. The apparatus is stopped and started by the ordinary artifice of a fast and loose pulley.

The operation of the device is as follows:—

The case or matrix "built up" in the manner before described, is thickly dusted with finely ground and "air floated" graphite, and introduced through the door of the chamber upon the plate of the machine; this is set in rapid rotation by the before described mechanism, and the swinging brushes sweep and spread the graphite uniformly over the surface, and into the finest lines of the mould. In about three minutes the operation is complete, the machine is stopped, and the mould removed, presenting a beautiful, lustrous, metallic-looking surface of graphite. (The machine commonly used for this purpose, is shown in Fig. 4, and its operation is too obvious to require explanation.) The excess of graphite is thrown, by centrifugal force, towards the sides of the chamber, and falls through the annular space between the periphery of the plate and the cylinder shell, accumulating on the bottom of the chamber, from which it is from time to time removed, to do service over again.

In this place, it may be as well to remark that the graphite used in every stage of the electrotyping process (and which it need hardly be explained, is used to provide conducting surface upon which the galvanic deposition of copper shall take place), must be of the purest description, and in the most minute state of division; an impure material would injuriously affect the electrical conductivity of the surface to be deposited upon, and the presence of any gritty particles would, of course, scratch and deface it. Hence the quality of the graphite is, for electrotypers, a material of prime importance, and producers of this article prepare electrotypers' stock with especial care.

Returning to our subject, the mould is now to be prepared for the coppering.

The workman, removing the case from the brushing machine, takes a stout copper wire, the end of which, for a length of about two inches, is bent at right angles, and thoroughly cleansing and heating it for an instant, imbeds this end of the wire into the wax on one side of the case. The wax is then scraped off to expose the metallic surface of the wire, and to establish electrical conductivity of the whole surface of the case, when the wire is properly connected in the battery. To insure this more perfectly the exposed part of the imbedded wire is rubbed with graphite from the finger. Trifling as this circumstance of exposing the imbedded wire appears to be, the galvanic deposit of the copper would be impossible, were it neglected, for the wax of the mass being a non-conductor of electricity, a galvanic circuit could not be established; the bringing of the wire to the surface, makes a conductor of the whole surface of the case when placed in the battery as the negative terminal, and establishes the galvanic circuit.

Having properly attached his wire, the operative next spreads around the sides of the mould a band of melted wax, to confine the deposit of copper where it is actually desired, and to avoid its unnecessary spreading out over the edges of the mould. This done, the case is passed to another workman who places it in a shallow trough, turns a stream of water upon it from a rose jet, to remove any particles of dirt or graphite remaining in the lines or letters.

He then ladles out of a vessel conveniently placed beside him, some concentrated solution of sulphate of copper, pours it upon the face of the mould, dusts on it from a pepper box a lot of very fine iron filings, and gently spreads the mixture over the whole surface with a fine brush, bringing out a thin, bright, adherent face of copper. This operation, preliminary to placing the cases in the battery, is known as Knight's process, and is, we understand, very generally in use amongst electrotypers. Its object is to provide the mould with a surface of eminent conducting qualities, so as to insure in the battery a uniform deposit of copper over the whole surface of the mould at once; without this preparation the copper in the battery would commence to be deposited at the place where the wire terminates, and would gradually spread from this, in all directions, over the surface. The portions next the wire would therefore receive the heaviest deposit, and those furthest from the wire, the thinnest.

The process just described obviates this objection, and insures the practical uniformity of the copper film. The case is then immersed in the electrotyping bath, a solution of sulphate of copper (blue stone). The bath is contained in a long rectangular tank of wood, a number of cases being suspended, back to back, in the bath at the same time, from hooks inserted in wooden cross-pieces. The ends of the wires are all joined to a metallic rod or strip, connecting with the positive pole of the battery, and the surfaces of the moulds, forming the negative terminals of the circuit. The positive terminal consists of a series of plates of copper, interposed between the cases and copper, similarly united with the negative pole of the battery. When the metallic connection is made, the circuit is complete, and the copper at once commences to be deposited upon the mould surfaces. The time required to secure a shell of copper of proper thickness, will vary, of course, according to the power of the battery, &c. An approximate idea, however, may be had from the statement, that a Smee battery (a zinc and silver couple with sulphuric acid as excitant) of 26 pairs, 12×12 inches, will copper from 6 to 6½ square feet of prepared moulds, in four hours.

In the establishment (Messrs. Mumford & Hanson) which has supplied us with the notes for this description the Weston Dynamo-Electrical-Machine† has been introduced to take the place of the battery, and with great satisfaction, the result being with the machine a working capacity about three to four times that of the battery of the foregoing dimensions, corresponding to a production of 22 square feet of copper shells in four hours. (The machine employed, it is claimed, will show under the best conditions, a duty of 53 sq. feet in 4 hours.) Fig. 5 gives an exterior view of the machine and Fig. 6 shows it connected and at work in an electrotyping establishment.

The case, when removed from the electrotyping bath, is taken to a trough, and a stream of hot water run on the copper surface for an instant, which artifice softens the wax below, sufficiently to allow the shell of copper to be stripped off. The shell is laid on a wire screen, and a ladle of hot lye is poured over its surface, to dissolve off any adhering particles of wax.

The back of the shell is then cleaned by the application of a soldering fluid (chloride of zinc and hydrochloric acid), then the shell, face down, is heated by laying it upon an iron soldering plate of peculiar shape, floated on a bath of stereotyping metal, and when hot enough, a solder (½ lead, ½ tin) is applied to the back, which gives a clean white metallic surface. This done, the shell, still face down, is again heated to the temperature of the stereotyping bath, on a floating iron plate with smooth surface. The plate is taken from the bath, supported in a level position on a table having projecting iron pins, upon which it is rested and the melted stereotype metal is ladled upon the back of the tinned shell. This process is called "backing up." The thickness of the metal backing is about ⅛ of an inch, enough to give the necessary rigidity to the shell to enable it to be printed from in the press.

The metal plate then passes to the finisher's department; it goes first to the saw table (Fig. 7), where the several subjects are roughly sawed apart, by a circular saw, the eyes of the operative being protected from the flying metal cuttings by an interposed plate of glass.

A rough shaving machine, moving the plate forward by successive steps, by a pawl and ratchet, take a series of rough transverse cuts off the back, and the plate then passes into the hands of the dresser, who, with a polished and perfectly level steel plate before him, proceeds to level the printing surface of the plate. With mallet and block it is first hammered down to a rough level; then taking a piece of charcoal, he goes over the copper surface with it, and, noting the spots where the charcoal still remains, after brushing off the dust, he marks the backs of the electroplate opposite these depressed spaces with a marking caliper; then turning the plate face down, he taps, with a small hammer, upon the marks, forcing the face of the plate up in these places; the dusting with charcoal, the markings with caliper, and hammering up are then repeated until a true printing surface is obtained. The plate then passes to the fine shaving machine (Fig. 8), where the back is shaved down to proper thickness smooth and level; the edges are planed down square and to proper size.

Then finally, to the carpenter, who mounts it, type high, upon a mahogany block, true and square. They are then ready to be delivered. Book work, it may be noticed finally, is not mounted on wood, the plates being finished, generally, with a beveled edge, which permits of their being held in a so-called "ratchet block," clamping the plate in the press by means of the bevel.

In the foregoing account, certain minor details of the numerous stages of the operation may have been overlooked, but the description, as a whole, will, we think, afford to the intelligent reader, a tolerably clear idea of the *modus operandi* of a very interesting and important industry.‡ W.

† Manufactured by Messrs. Condit, Hanson & Van Winkle, Newark, N.J.

‡ Our thanks are due to the *Messrs. Mumford & Hanson* for much courtesy in affording us every facility to inspect the whole process of electrotyping as practiced in their model establishment. For the use of the engravings, numbered 1, 2, 3, 4, 7 and 8 we are under obligations to the manufacturers, Messrs. Hoe & Co., of New York.

Fig. 1.—Toggle Moulding Press with Lifting Head.

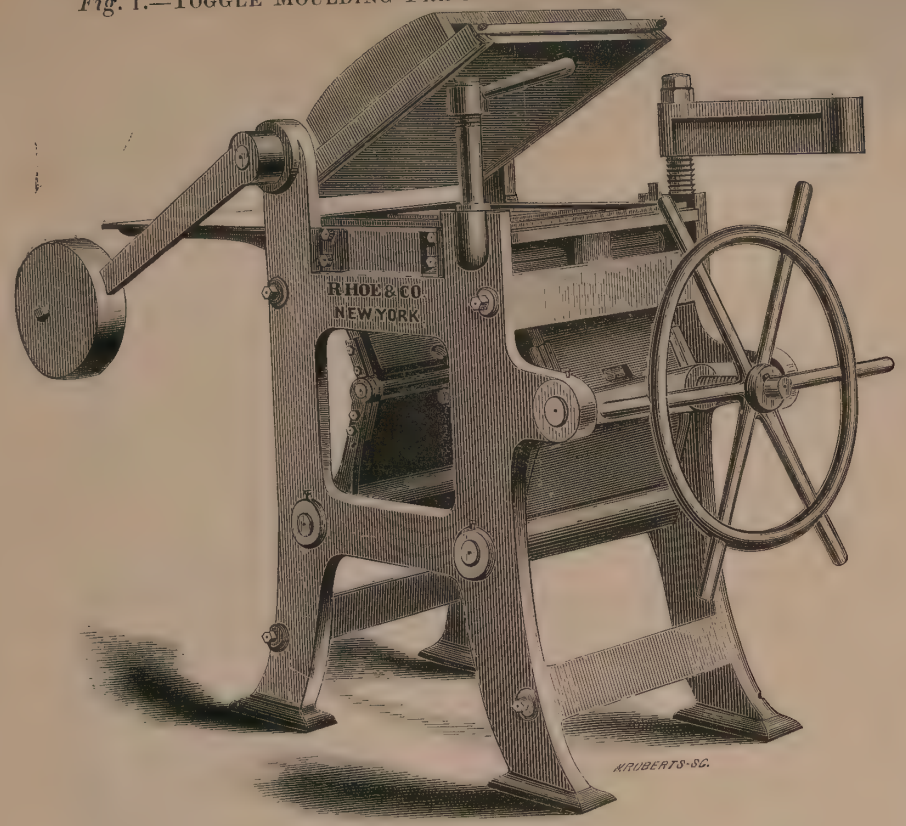


Fig. 8.—Shaving Machine.

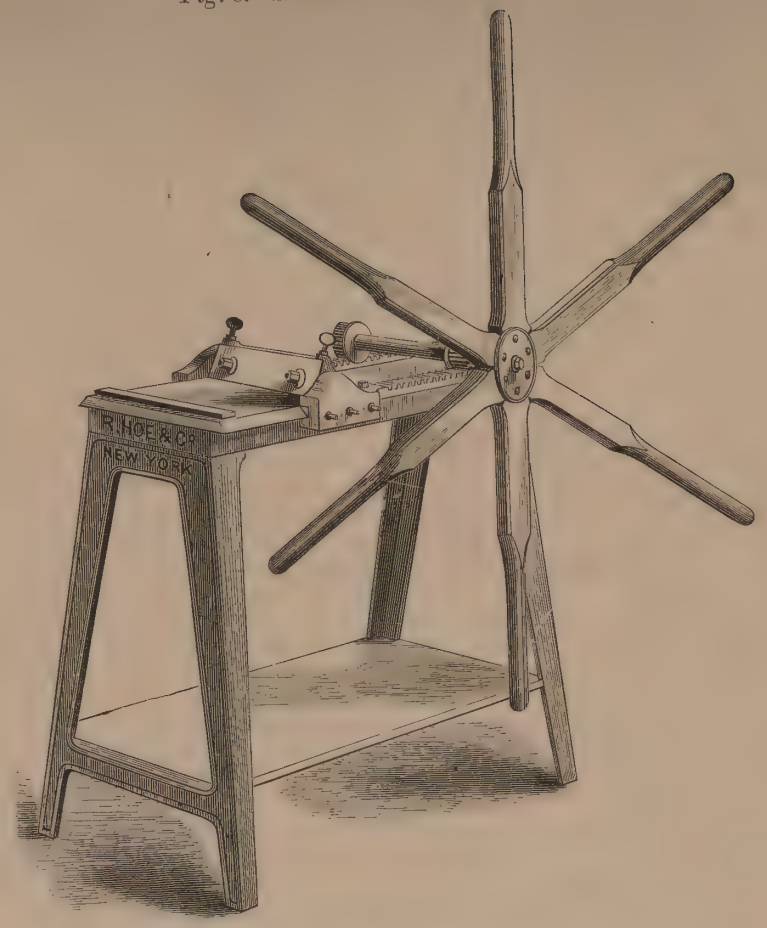


Fig. 2.—Hydraulic Moulding Press.

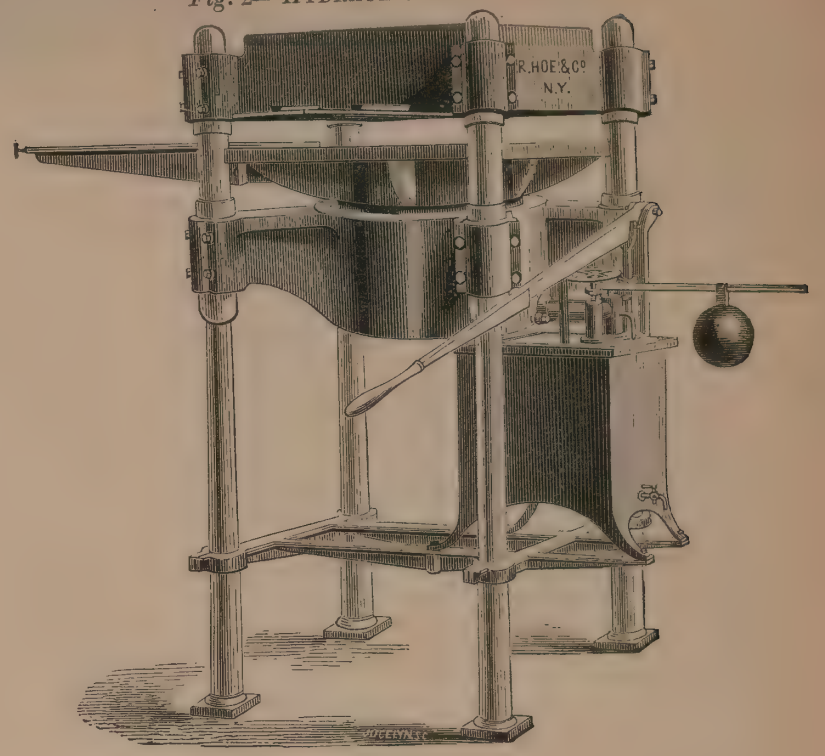


Fig. 7. Saw Table.

Fig. 4.—Black Leading Machine.

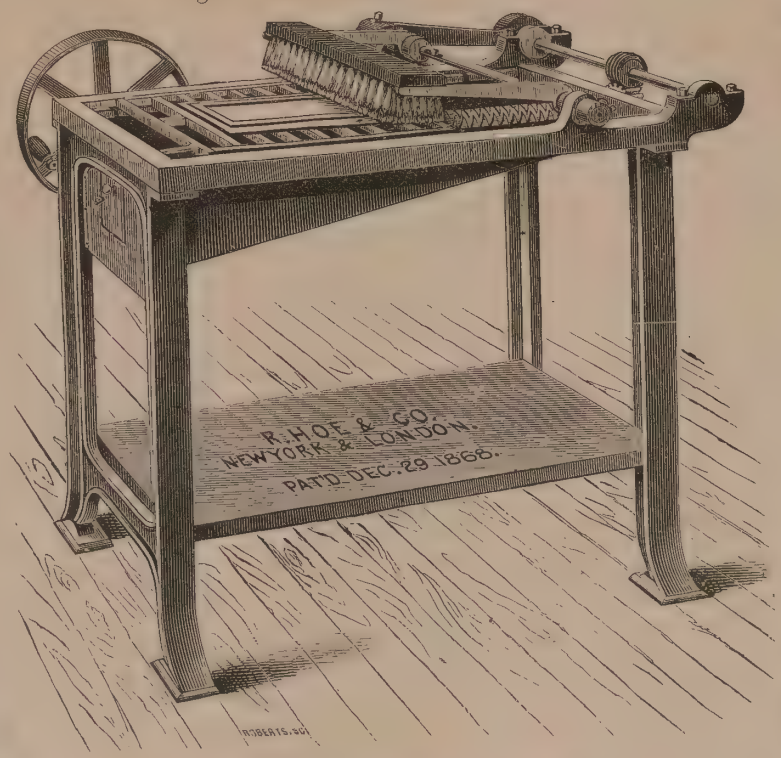


Fig. 3.—The Building Iron.

Fig. 5.—Weston's Dynamo-Electric Machine.

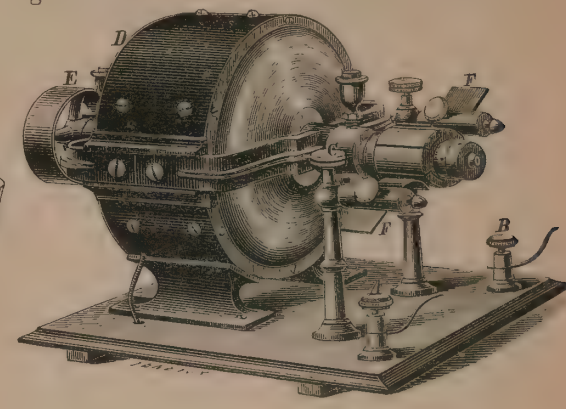
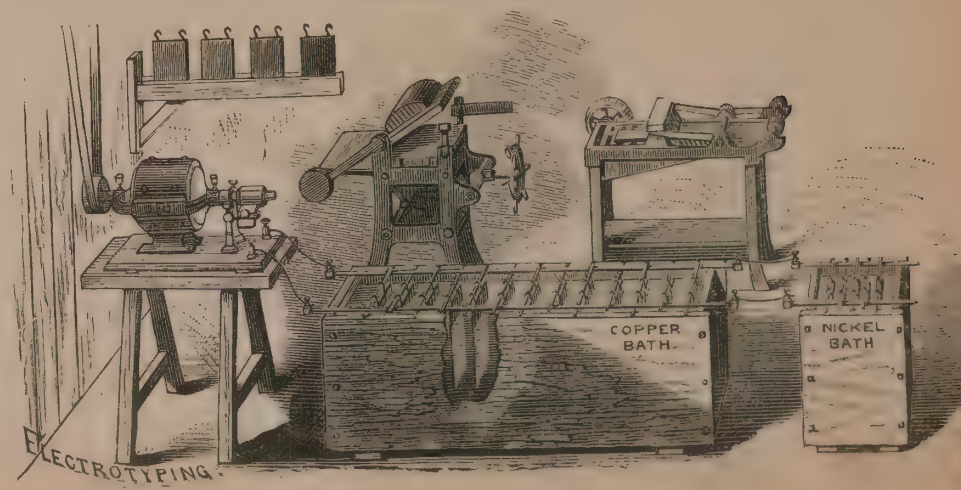


Fig. 6.—Dynamo-Electric Machine at Work in an Electrotyping and Plating Establishment.



TOOLS AND MACHINERY
USED IN ELECTROTYPING.

MEASUREMENT OF WATER MECHANICALLY SUSPENDED IN STEAM.*

By J. B. KNIGHT.

Having for a long time felt the want of a more satisfactory method of determining the amount of water carried out of the boiler by the mechanical action of the steam, when determining the evaporative efficiency of steam boilers, I conceived a device about January 1st, 1874, which, so far as depending upon the weight of a measured quantity of entrapped steam, was identical with that of Palamede Guzzi, an account of which was given in our last issue.

Preferring to submit my design to the test of experiment before publishing it, and being prevented from doing so up to this time, M. Guzzi is, of course, entitled to the claim of priority.

It now becomes desirable, however, that I should give my plan, as it covers some points not embodied in his, and which seem essential to the accuracy of the result.

The advantages claimed for my plan are: entrapping the steam to be tested, in exactly the condition in which it passes from the boiler in the normal condition of working; and depending entirely upon the weight of the steam entrapped, thus avoiding errors arising from losses of heat during the experiment.

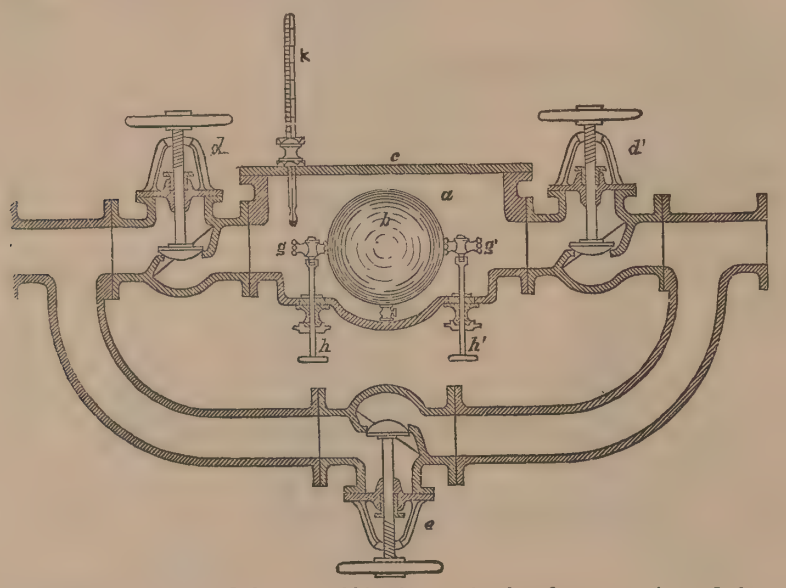
All the methods heretofore proposed, including that of Mr. Guzzi, fail entirely in one or the other of these particulars.

The article referred to gives the plan of Prof. G. A. Hirn as the best yet suggested, and which consists in measuring the total *heat* of a given weight of the steam under examination, and comparing it with that of dry saturated steam at the same pressure and temperature. The apparatus there described consists of a simple condensing coil.

Another form of apparatus for this method is that used in the boiler tests at the Centennial Exhibition, and described in detail on page 111, current vol. of the *Journal of the Franklin Institute*, and is considered the best in this country.

By this method, whatever the apparatus used, corrections have to be made for losses by radiation from the conducting pipe and condensing vessel, and for absorption by the vessel, if of wood, and of the specific heat of the vessels, and of the stirring apparatus, none of which can be more than approximately ascertained.

In the apparatus of M. Guzzi, the copper vessel in which the steam is to be weighed is inclosed in, and filled from, an outside chamber with non-conducting sides, connected by a pipe to the steam dome of the boiler. With this arrangement, the steam, not being taken from the principal outlet of the boiler, is not of the normal quality, and is subject to some loss of heat by radiation from the chamber and connections. Moreover, after entering the weighing vessel, the steam is allowed to stand in a quiet state, and all the water held in suspension will be precipitated.



The apparatus proposed by myself is shown in the figure, as intended to be inserted in the steam-pipe leading to the engine. A chamber *d*, formed by an enlargement of the pipe, has an opening at the top large enough to admit the vessel *b*; the opening to be covered by means of the lid *c*. At each end of the chamber are the stop-valves *dd'*, and just beyond these is a by-pass, having in it the valve *e*. It is obvious that when the valves *dd'* are open and *e* closed, all the steam, on its way to the engine, must pass through the chamber *a*; or if it be desired to open the chamber, the valves being reversed, the steam will pass around the chamber through the by-pass.

The copper vessel *b* (made spherical in form for the purpose of enclosing a given space with the least weight of metal), has outlets on each side through the cocks *gg'*, operated by the handles on the spindles *hh'* passing through the bottom of chamber *e*. At the bottom of the vessel *b*, and operated from the outside in the same manner as the cocks *gg'*, is a small cock *i*, by means of which any water resulting from heating it up to the temperature of the steam can be drawn off.

In the lid or cover of the chamber is a stuffing-box, through which is inserted the thermometer *k*, for the purpose of ascertaining the temperature of the steam; the pressure being taken from a gauge attached to a boiler.

The mode of operating is as follows: Place the copper vessel *b* in position, with its outlets open and in line with those of the chamber *a*, the drain cock *i* also being open, and when the boiler is in full action open the valves *dd'*, and close *e*. All the steam thus being caused to pass through the chamber *a*, through and around the copper vessel *b*, the steam in the latter must be, in every particular of temperature, pressure and saturation, in exactly the same condition as all that leaves the boiler.

When this has continued for a sufficient length of time to insure the proper heating of the chamber and its contents, close the cocks *gg'* and *i* simultaneously, and we have entrapped in the vessel *b* a quantity of steam of the quality due to the normal working of the boiler.

Now open the valve *e* and close *dd'*; remove the lid *c*, when the vessel *b* may be taken out and weighed. From this weight deduct that of the empty vessel, and the remainder will be the weight of the mixture of steam and water contained in it. A comparison between this and the weight of the same volume of dry saturated steam at the same temperature, will give the percentage of water carried out of the boiler by the mechanical action of the steam.

It is evident that no allowances have to be made for radiation, or for the specific heat of the materials used, as we simply weigh the supersaturated steam carried from the boiler in actual service, and compare it with dry saturated steam.

* From the *Journal of the Franklin Institute*, to which we are indebted for the cut.

SEAMLESS VESSELS.

The advantages of seamless over seamed vessels are their exemption from leakage and their superior cleanliness; there being no sharp interior angles or exterior flanges to retain moisture and cause rust, or to catch and hold minute portions of the contents. It might at first be supposed that the process of stamping or even of spinning-made some limitations as to the shape and comparative depth of such vessels; but while in truth a shallow vessel or object is more readily made than a deep one, and flaring or perpendicular sides. These arts have so far progressed that even by the more rapid stamping process, perpendicular sides of considerable comparative depth are produced. As yet, we believe that no vessels with sides tapering upwards and inwards have been stamped, owing to the question of removing the plunger and of filling sharply the lines of the die. But this work could be effected if there were a demand for it; sectional dies and expanding plungers could and would be made to perform the work thoroughly and perhaps as expeditiously as cheapness would demand. There are few limits which we can place upon the practical, and almost none upon the theoretical capabilities of mechanism and machinery; more especially as we now have the kinematics of machinery so thorougly expounded by the theorists of Europe, and the inventors of America, to effect its practical application.

The whole matter of stamping or striking up concave forms from metal, rests upon the fact that there is a certain amount of flow or internal movement permissible to the particles of all solids; and that with inelastic solids this flow when occasioned by pressure is not reversed or reciprocated as in elastic bodies; the "set" or change of form is permanent. In this respect lead has the same quality as putty, but in less marked degree; and so on up the scale of so-called inelastic bodies, and even into the domain of springy or elastic bodies, which may be given a permanent set by abnormal pressure. Some elastic bodies take their set under steady and prolonged pressure and others under sudden force only; and we must not then find it strange that some inelastic substances will flow under steady pressure better than under a blow, and *vice versa*.

The changing a flat disc of copper into a cartridge case, having a length four times its internal diameter, is not any more wonderful than the rolling of an ingot or bloom of iron into bars and its subsequent drawing into fine wire. The weight remains the same; the proportions have been changed, and the density increased. In the case of stamping the process has this advantage over the rolling, that the guiding or forming is more perfectly limited and the ragged and unformed, because unguided, portions of the finished product is at one end instead of at two.

To stamp deep vessels, successive moulds, of varying depths, are employed.

The sheet of metal must have a width equal to the width and depth of the required vessel. The more moulds there are used, the less chance of wrinkling the metal and splitting the edges.

In making copper cartridge cases there are as many as five moulds and plungers, independent of the "rimmer," which buckles out the head or flange.

There is a holder (a plate with a circular opening just the size of the lower mould), between which and the upper surface of the lower mould, the disc is clamped firmly, and the metal found to expand and to follow the plunger.

If there were no holder, the disc would simply buckle up and be driven down irregularly into the mould.

As long ago as 1840, the production of deep stamped metal vessels was undertaken in France; but the employment of the drop press was early superseded by the cam, crank or toggle press.

Where the vessel is made from sheet iron it is sometimes re-annealed after each stamping, and is subsequently tinned. The employment of tinned plate permits of fine finish, and no re-dipping is now employed. G.

THE BEHAVIOR OF STEEL DURING HARDENING.

There appears every reason to believe that cast steel undergoes a structural change during the last stages of cooling in the hardening process, and that this fact has not been recognized save by operative workmen, since no mention is made of it in works upon hardening. The facts upon which this opinion is based are as follows: File hardeners take the files from the cooling water when cooled to a temperature of about 100° Fahr., and after sighting the file, to ascertain its straightness, pour cold water on the rounding side of the file, which by contraction tends to straighten it. If, however, the file has once been reduced to the temperature of the atmosphere, repeating an application of cold water on either side of the file will have no effect whatever.

Some tool hardeners place beside the forge a plate pierced with holes of various sizes, and in the case of such tools as reamers, extract them from the cooling water before cooled to the temperature of the water (while hot enough to cause the water adhering to the tool when extracted, to dry rapidly off); after sighting them with the eye, to note in which direction they may be bent, they place them in a suitably sized hole in the plate mentioned, and with the hollow side of the tool uppermost, exert a pressure upon it to straighten it. These men also assert that by this means a tool bent in the cooling can be straightened, but that if the steel has once become cooled after the hardening the operation will have no effect whatever. From this it appears that during the first stages of the cooling the structural formation of the steel undergoes a change, which may be influenced by pressure, whether produced by the strain of contraction or by mechanical means, and that this structural change terminates in a permanent set. This subject is well worthy of investigation.

JOSHUA ROSE.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Symes' Coal Gas Process.—An exhibition of Symes's process of making coal-gas was given last Saturday at the Collinge Engineering Works, Westminster Bridge-road, in the presence of a large company of scientific men, both British and foreign. The advantages claimed for the process, is that a greater quantity of gas is obtained, of a superior illuminating power; that the product is practically free from sulphur and ammonia, and that the manufacture can be carried on without annoyance to the neighbors and by unskilled labor. The necessary apparatus certainly occupies a remarkably small space, but it was said to be equal to supplying 50 lights. The main feature of the invention is that nearly all the tar is utilized. Instead of passing off into the hydraulic main, it is detained and thrown back into the retort, the gas passing through ingeniously-constructed purifiers, where it is freed from ammonia and sulphur. By this utilization of the greater part of the tar, the yield of the gas per ton of coal amounts to 13,000 cubic feet instead of 10,000, the usual amount from good coal mixed with a small proportion of cannel. Symes' gas is certified to contain less than 3 grains of sulphur per 100 cubic feet, whereas the companies profess their inability to reduce it below 25 grains, and only reach that standard with difficulty. The cost of making the gas is stated to be 1s. 6d. per 1,000 cubic feet, so that, allowing a liberal per centage for wear and tear, and interest on capital, a considerable saving can be effected.—*English Mechanic & World of Science.*, xxvi, 209.

Manure From Sardine Refuse.—Works have recently been established at Kernevel, (Morbihan, France), in the neighborhood of the numerous sardine works there, for converting into manure all the detritus proceeding from the latter. This detritus, consisting of the heads, cartilages and intestines, is placed on sloping tables, and there drains off a mixture of brine and blood soil, which is pumped up and utilized to enrich dunghills and meadow land in the neighborhood. The liquid undergoes automatical fermentation in the trench, and its action on vegetation is very strong; it contains about 1:34 per cent. of nitrogen. The solid detritus, after draining, is cooked in boilers with open fire (two hours per 400 kilog. of sardine heads). Then it is piled in layers between plates of sheet metal, and subjected for three hours to the action of a press whence it emerges in the state of a cake. * * This is dried in air and pulverized in a mill, from whence it comes ready for agriculture. The manure contains about 50.50 per cent. organic matter, 6.50 nitrogen, 5 water and 38 ashes. Compound manures are also formed in one case by mixing the fish-cake with a sort of fucus obtained at low water. Also, phospho-guano is made by treating broken fish-cake with sulphuric acid at 50°; it is gradually reduced to a paste and dried. This is an excellent manure, for beet especially.—*English Mechanic & World of Science*, xxvi, 210.

The Magnetic Properties of Pure Nickel have been lately investigated by M. Wild, of St. Petersburg, who procured a nickle magnet in the form a flae-pointed bar, made by Wharton, in Philadelphia. The results are as follows:—1. Pure nickel takes, as compared with the behavior of pure soft iron, a considerable quality of permanent magnetism; but the maximum of this is only a half to a third of the permanent magnetism which may be acquired by hard steel. 2. The magnetism remaining in nickle after cessation of the magnetising force is less permanent than in well-hardened steel; the gradual loss of magnetism in course of time, both in warming and cooling, is in nickel greater than in hard steel, even when, by repeated heating and cooling it has, like steel, been brought to a certain state of permanence. 3. The temperature-coefficient of nickel magnets in the latter state is less than that of well-hardened steel. 4. The temporary magnetism which pure nickel acquires is about double its permanent magneting moment, half of the temporary magnetism which hard steel can acquire, and a fourth of that which soft iron can acquire. In its magnetic behavior, nickel is thus throughout subordinate to steel and iron.—*English Mechanic and World of Science*, xxvi, 184.

Ancient Lighning-Rods.—Dr. Munke quotes a passage from the "Talmud," written in the fourth or fifth century of our era, permitting the use of iron "as a protection from lightning and thunder." Wiederman, in an editorial note, that the Egytians seemed to have employed gilded masts "for warding off the bad weather coming from heaven.—*Annalen der Physik und Chemie.*

The "Hygroscopic Flowers," which change their color according to the degree of moisture in the atmosphere, and which are supposed to be a modern invention, were suggested by Herbelot in 1737, and were made on a commercial scale in 1792.—*Les Mondes, per Chemical News*, xxxvi, 205.

ENGINEERING—CIVIL AND MECHANICAL, &c.

New Docks on the Clyde.—A few weeks ago extensive new docks were opened at Stobcross, on the Clyde. The depth of water in the dock is 120 feet, and the entire cost will be about £1,600,000. When the dock is entirely finished the water-surface will extend to 34 acres, the length being 3,000 feet, and the breadth 700 feet. Access to the basin which is a tidal one, is obtained at the south-west extremity, the passage being 180 feet in width. On the north side the wall of the quay is founded to the depth of 41 feet below the level of the quays. A central quay passes from the eastern end parallel with the north and south side walls, separated from them by water-ways for distance of 270 feet with a uniform breadth of 195 feet. The water-space between the western end of this quay and the west wall of the dock forms a canting ground, and is of such dimensions as will permit of the largest vessels being moved and turned about with every freedom. A strong iron bridge on the swing principle has been placed at the entrance to the dock, and although it weighs 800 tons, is 181 feet long, and 40 feet broad, can be moved from one side to the other in a minute and a half. The bridge is worked by hydraulic power, supplied from an engine-house placed in the vicinity, and which, by means of pipes, can be connected with cranes and similar machinery at any portion of the dock. The engine-house is a handsome building, and is surmounted by a tower, in which a clock and a chime of bells have been placed.—*Mining & Scientific Press*, xxxv, 294.

The Hudson River Tunnel.—The work upon the tunnel under the Hudson river, between Jersey City and New York, which has been delayed for some time by litigation, it is now stated, will be resumed early this fall. *Engineering News* says: A shaft 27 feet deep has been dug at the foot of Fifteenth Street, Jersey City, and this depth will be increased 20 feet. From this as a starting point, the tunnel will proceed in a northeasterly direction under the Hudson River and the Christopher Street ferry slip. The entrance on the New York side will be in the neighborhood of Washington square. From Jersey City the grade will descend two feet in every 100 feet, until a point 27,000 feet from the New York side is reached, when it will begin to ascend at the rate of 1 foot in every 100 feet. The tunnel will be two miles in length, with a road-bed 23 feet wide and two separate tracks. Through its entire length it will be lighted by gas. The wall will be constructed of brick, with a thickness of four feet. At no point will the top of the tunnel be less than 35 feet below the surface of the water, and in many places it will be 70 feet below. One hundred and twenty laborers will be engaged in the construction of the tunnel. The work will go on during the whole of the 24 hours, the force working in three relays, of eight hours each. Although the tunnel will be used for the conveyance of passengers, its main object will be the transportation of freight to and from the great railroad lines which terminate in Jersey City. The capital of the company is $2,000,000.—*Mining & Scientific Press*, xxxv, 294.

How a Boy Helped the Growth of the Steam Engine.—The steam-engine has now assumed a form that somewhat resembles the modern machine.

An important defect still existed in the necessity of keeping an attendant by the engine to open and shut the cocks. A bright boy, however, Humphrey Potter, to whom was assigned this duty on a Newcomen engine in 1713, contrived what he called a *scoggan*—a catch rigged with a cord from the beam overhead—which performed the work for him.

The boy, thus making the operation of the valve-gear automatic, increased the speed of the engine to fifteen or sixteen strokes a minute, and gave it a regularity and certainty of action that could only be obtained by such an adjustment of its valves.

This ingenious young mechanic afterward became a skillful workman, and an excellent engineer, and went abroad on the Continent, where he erected several fine engines.

Potter's rude valve-gear was soon improved by Henry Beighton, and the new device was applied to an engine which that talented engineer erected at Newcastle-on-Tyne, in 1718, in which engine he substituted substantial materials for Potter's unmechanical arrangement of cords.—*Prof. Thurston*, in *Popular Science Monthly for December.*

Comparative Strength of Wood and Cast Iron.—Herr Hirn has been conducting a series of experiments in Germany, on the comparative strength of wood and cast iron in their different applications, and finds that in a great number of cases the former has the advantage. Professor Hirn finds the strength of wood to be in direct ratio to its density, and this strength is increased by immersing the pieces of wood in linseed oil, heated from 185 deg. to 212 deg. Fah., and letting the wood, thus immersed, remain for two or three days, or until partially saturated.—*The Engineer*, lxlv, 313.

MISCELLANEOUS.

Value of the Eucalyptus.—We learn, from the *Meteorological Magazine*, that, at the Easter re-union at the Sorbonne, some information was given by Dr. de Fietra Santa, a delegate from the Climotological Society of Algiers, as to the results of an investigation made in Algeria, to ascertain the importance and value of the *Eucalyptus globulus* in relation to public health. It appears that reports were received from fifty localities where the aggregate number of blue gum trees is nearly 1,000,000, and from these reports the following conclusions have been drawn: 1. It is incontestably proved that the eucalyptus possesses sanitary influence; for 2, wherever it has been cultivated, intermittent fever has considerably decreased, both in intensity and frequency; and 3, marshy and uncultivated lands have thus been rendered healthy and transformed. Similar results have been obtained in Corsica, where it is computed that, in the present year, there will be upwards of 600,000 plants of eucalyptus in full growth.

The English Postal Service.—The report of the Postmaster-General, of Great Britain, for 1876, issued on Sept. 5, states that the total number of letters which passed through the post-offices in the United Kingdom during that year was 1,018,955,200, equal to thirty-one letters per head of the population; the number of post cards was 92,935,700, and of newspapers and book-packets 298,790,800, of which the newspapers alone numbered 125,065,800. The number of registered letters was 5,095,116. One of these letters, addressed to a bank, and containing £3,000, was found to be unfastened. The number of returned letters was 5,897,724. Upward of 33,000 letters were posted without addresses; and of these 832 were found to contain nearly £390 in cash and bank notes, and nearly £5,000 in cheques. 78,575 postage stamps were found loose in different post-offices, having been insecurely fixed, and 14,346 articles were found without covers.

Philadelphia Locomotives for Russia.—Sometime ago the agent of the Baldwin Locomotive Works, in St. Petersburg, Russia, sent the establishment a cable dispatch, stating that the Imperial Government required a large number of locomotives at once, and asking whether the Baldwin Works could finish forty first-class engines by February, 1878, and intimating that that large order, if given, would be followed by one still larger. Mr. Charles T. Parry, one of the company, sailed from New York for Europe on the steamer Celtic, last Saturday, and will proceed at once to St. Petersburg, where he hopes to close the contracts.

The Baldwin Works are now quite busy, and are completing on an average four engines a week, employing 1,100 hands. They have facilities for building ten engines a week and employing 3,000 hands should business require it. They are now shipping four narrow-gauge engines to Rio de Janerio, Brazil, three to Cuba, three to Queensland, Australia, and two steam street cars for California. They will ship this week, two narrow gauge engines for the Denver (Colorado) and Rio Grande Railroad, and one for the Atchison, Topeka and Santa Fe Railroad. They are also building one to be sent to St. John, New Brunswick, and one for the Willard Asylum, near Watkins Glen, N. Y.—*Phila. Ledger.*

Singing Mice—The question as to whether mice sing, has been revived. M. Prierre described before the Society of Acclimitization his experience in La Vendee in 1851-3. He had bought an old cupboard which happened to contain mice. About sunset the mice began to sing. By lubricating the doors and hinges of the cupboard, M. Brierre was enabled to open it in one instance, without disturbing the song. He literally caught the songster in the act. It was an old mouse, which held its nose in air like a dog when howling. Its song was like that of a wren. M. Brierre seized the mouse in his hand, but afterward allowed it to escape. On subsequent evenings the singing was renewed. There were no birds in the house. The utterance of a less musical sound has latterly been discovered as part of the capacity of the scorpion, on the authority of Mr. J. Wood Mason, and described before the London Eutomological Society. The experiments were made at Bombay, by teasing two large scorpions, placed face to face on a table. The sound is stridulous, somewhat like that from scraping a stiff brush with the finger-nails. An anatomical examination showed that the insect is provided with an apparatus consisting of a scraper and a rasp; these appendages could be made to give sound when separated from the scorpions, after death.—*N. Y. Tribune.*

—The publications of Nystrom's Elements of Mechanics and Steam Engineering have both been transferred to G. P. Putnam's Sons, New York.

—The electric light at the depot of the Paris and Lyons Railroad is now one of the sights of the French capital.

Lumber and Salt Interests of the Saginaw Valley.—A very large proportion of the lumber, lath and shingles—perhaps more than half—and a considerable portion of the salt produced in the United States is manufactured in the Saginaw Valley, in this State. The Saginaw River with its tributaries, the Cass, Bad, Flint and Tittabawassee Rivers, drains a large extent of what was once the largest and finest growth of pine timber to be found in the United States. And, though it is now shorn of a part of its former magnificent proportions, it is still of sufficient magnitude to ensure the continuance of the Saginaw and Bay City, as the most important lumber marts of the United States for many years to come. From the lower part of Bay city, five miles from the head of Saginaw Bay, to East Saginaw and Saginaw City, a distance of twenty miles, the Saginaw River is lined on each side with saw-mills, vast piles of lumber, and salt works. Nearly every lumber-mill has salt works attached to it, the brine being boiled by the exhausted or waste steam from the saw-mill.

The advantages of the Saginaw Valley for the development of the lumber trade were exceptional, but even when these are taken into consideration, its growth has been phenomenal. In 1853 there were only sixty-one mills in all the territory embraced within Saginaw, Bay, Shiawasse and Genesee Counties Of these, twenty-three were on the Saginaw River. The manufacturing capacity of these mills for the season's work (from May to November) was estimated at 100,000,000 feet. In this territory there are now more than 300 mills, with a manufacturing capacity of 1,000,000,000 feet. From 1853 to 1863 no record was kept of the production of the mills in the Saginaw Valley and the adjacent territory within these four counties. Since 1863, however, the record is complete. The figures show how marvelous was the growth for the following ten years. The year 1873 marked apparently the culmination of the growth of the lumber manufacture in this valley. The following are the figures :

Year,	Feet,	Year,	Feet.
1863,	133,500,000.	1870,	576,726,606
1864,	215,000,000.	1871,	529,682,878
1865,	250,639,340.	1872,	602,118,980
1866,	349,767,884.	1873,	619,897,021
1867,	423,963,190.	1874,	574,632,771
1868,	457,396,225.	1875,	571,401,001
1869,	523,500,830.	1876.	570,782,885

No branch of business felt the panic of 1873, and the succeeding business depression, more severely than the lumber trade. The price of lumber fell nearly or quite 50 per cent. for some grades. The mill owners found themselves with large stocks on hand at the close of each season, and little demand for them, except at ruinously low prices, although lake freights were lower than ever before. There seems to be a more hopeful feeling. Since the beginning of the month large purchases have been made, and a slight advance over the prices of the various grades for August. A correspondent of the New York *Tribune*, who has lately been visiting this valley, reports that in one day, there were cleared from the Custom House at Bay City over 8,000,000 feet of lumber, the largest amount ever recorded for a single day. It is doubtful, however, if there is ever again the same amount of lumber sawed here in one season that there was in 1873. The best quality of pine has been cut for many miles on either side of the streams that empty into the Saginaw River and tributaries, and the cost of getting the logs down to the mills at Bay City, East Saginaw, and Saginaw each season is greater. Lumber can be manufactured more cheaply by the mills built on the streams which empty into Lakes Huron and Michigan in the northern part of the State, where the forests have been untouched, and the logs, when cut, do not have to be drawn and floated so far. Still, as previously stated, it will be many years before the Saginaw Valley ceases to be a great lumber mart, and, in any contingency, it will still have its salt production, the wells from which the brine is drawn being seemingly inexhaustable.

Philadelphia Industries—Street Cars for all parts of the World.—The building of street cars and cars for narrow gauge steam railways, is carried on to a very large extent in this city, the Philadelphia Car Works of Messrs. J. G. Brill & Co., at Thirty-first and Chestnut streets, being the most extensive establishment devoted to this line of manufacture. The firm made a large and handsome display of their cars at the Centennial Exhibition, and to this fact they attribute the receipt of several large orders which they are now filling. They have just finished two one-horse cars to go to Milan, Italy, as samples for use on the recently constructed railway from Milan to Monza, a small town about ten miles from Milan. English built cars have been in use heretofore on the road, but the attention of some of the Italian Commissioners at the Centennial was attracted by the greater beauty and convenience of the Philadelphia cars, and an order was sent for these two as specimens, with an intimation that if they gave satisfaction a large order would follow. The cars are painted yellow, ornamented with gilding, and the seats are of wooden slats. They are in every respect similar to the ordinary Philadelphia street-car, except that there are no plush cushions. A two-horse car similar to those in use on the Market street road has also been recently built to the order of a street railway in Berlin, as a sample car, with the understanding that if it meets the expectations of the managers, many more will be ordered. Messrs. Brill & Co. have also under way twenty one-horse cars for the Dry Dock, East Broadway and Battery Railway Company, of New York city, whose depot was recently destroyed by fire, burning most of their cars. They have also finished recently six narrow gauge steam cars for a railway in Cuba, and are preparing the entire equipment for a horse railway now in course of construction in Port-au-Prince, Hayti. The road will be completed by January 1878. The rolling stock, now building, consists of four passenger cars and ten freight cars, the latter being six feet wide by ten feet long, and are to be used for hauling coffee.

The firm also have a large order for street cars from Chicago, whither they have already sent a great many. Since the establishment of these works, in 1869, they have sent cars, in addition to those mentioned above, to the city of Mexico, Vienna, Callao, Peru, Boston, Lynn, New Haven, New York, Trenton, Cincinnati, Chicago, Columbus, St. Louis, where they completely equipped two roads. Zanesville, Ohio; Savannah, Georgia; Hamilton, Ontario, Dubuque, Kansas City, Reading, Wheeling, Alexandria, Norfolk, Pittsburgh, and many other cities. They have furnished all the rolling stock for three of the popular steam roads running from Brooklyn to Coney Island, and a large number of inclined plan cars for Oil city, Pa., and Cincinnati, Ohio. They have now about one hundred men at work, and when their force is full they will employ about one hundred and thirty. They occupy a lot of ground eighty feet wide, extending from Thirtieth to Thirty-first streets, on which are all the necessary shops, sheds and other buildings containing the machinery and materials for the prompt and convenient transaction of their business.—*Phila. Ledger.*

—The Bay of Funday red and gray grantite are becoming deservedly popular for building and monumental purposes.

—The starting of the Woodruff scientific expedition around the world, which was to have taken place this month, has been postponed till May 15, 1878.

MANUFACTURING AND INDUSTRIAL NOTES.

—A neat contrivance is the Basket Slop Hopper (J. L. Moot Ironworks, N. Y.) to be placed in the yard or elsewhere; the liquid portion of the slops drain off into the sewer or gutter and the solid remain "for the pigs."

—Plans are wanted for a new State House, Indianapolis, Ind, Proposals are invited by A. H. Polk, Princeton, Ind., for 120 feet wooden bridge at Dongola, Gibson Co., Ind., for ditching Mud Creek, Mich., (Charles Glasier, West Bay City); by Josiah Kimeran for grading streets in Columbus, O.; by Thos. White, Alpena, Mich., for constructing State road between Torch Lake and Alpena Swamp Land; by A. J. Spencer, Cleveland Ohio, for three 800 bbl. reservoirs, etc.

—A curious combination of manufactures is that of Messrs. W. C. Allison & Co., Phila., (iron pipe and railway cars). Another is that of the Gilbert and Bennett Manufacturing Co., Georgetown, Conn., (iron-wire and glue and curled hair). Several Philadelphia firms sell "rags and marble"; the rags coming from Italy as stuffing between the marble blocks.

—A new stove-pipe (made by Chicago Stamping Co.,) is so made as to roll up or slide together with great compactness for shipping. Fifty joints of five inch are packed in a case 10×10×24 inches. Over each roll is drawn one joint of pipe to protect the others.

—There are extensive mica mines at Chester, Mass., and in North Carolina, which supply most of our mica used by stove-makers and others in this county.

—The very appropriate trade-mark of the Russia iron, made by W. D. Wood & Co., Pittsburg, is the American eagle demolishing the Russian bear. American "Russia" iron and leather are fully equal to the imported.

—The largest pump works in the world are those of Rumsey & Co., Seneca Falls, N. Y.

—The American File Co., of Pawtucket, R. I., uses the "Bernot process" for cutting files by machinery. Very sensibly these manufacturers have tested files of all known manufacturers, and compiled tables showing the working qualities of them all, and of files made from different steels and with various shapes and angles of teeth.

—We note a curious design, a "malleable iron axe wedge," made by the American Sleigh and Carriage Iron Co., Boston; and would like to test one.

—A neat knob-screw (made by Thurston Knob Screw Co., Marlboro, N. H.,) is made by screwing into a wooden knob, one end of a double ended gimblet pointed screw, having a longitudinal feather to keep it from turning after properly inserted.

—We note a horse shoe having a steel center layer, which should prevent the nail holes from enlarging, and also keep the calks sharp on the "squirrel-tooth" plan.

—There is a National Fine Art Foundry at 218 E. 25th street, N. Y.

—The American Screw Co., Providence, R. I., is making gimlet pointed screws, having no sharp angle at the ordinary weak point (the heel of the thread) and with the outer periphery of the thread upon its body cylindrical, while a portion of the body below the thread and near the neck is coinca, the remainder of the body to the point being cylindrical, and yet having all the thread brought to an edge of a constant angle, without jogs in the paths between the threads. This should make a strong screw.

—The Frary Cutlery Co., Bridgeport, Conn., is making a table knife with a screw tang, obviating the annoyance of the scale tang, that the cement cracks and the tangs pull out of the handle.

—A neat device is a seamless metal-rimmed sieve, made by E. Ketcham & Co., 100 Beekman St., N. Y.

—The Nicholson File Co., Providence, R. I., is engaged upon a treatise on "the file and its uses."

—We note a neat shooting-board made by Shipman & Binder, Rochester. It seems specially adopted for planning pyramids.

—The best stop yet accomplished in the world with the air-brakes, is claimed for the Longbridge patent; train of 250 tons, 10 cars; speed 42.6 miles per hour; time in stopping, 16 seconds; distance run, 587 feet, 8 inches.

—The Cambria Iron and Steel Works, Johnstown, Pa., have now an annual capacity of 100,000 tons.

—We are pleased with the idea of a "revolving lathe tool holder", made by J. P. Richards, Providence, R. I.

—We note a "Railway Speed Recorder" made by the R'y Speed Recorder Co., Kent, Ohio.

—An excellent device for heating locomotive tires by a circle of gas-jets, is made by S. G. Reed, Boston, and should prove a convenience in railroad shops that have gas. It is stated that four tires were put on with 400 cubic feet of gas; and that two men "shim" a set in two hours, with six minutes heating to remove, and one shop removes in twelve minutes, using seven cubic feet per minute.

—The Trenton, N. J., Vise and Toolworks, make a "rapid transit" parallel vise, having no toggle or cam-movements or parts. It seems compact and strong and would doubtless be worth testing.

EDITORIAL CORRESPONDENCE.

TO THE EDITORS OF THE POLYTECHNIC REVIEW :—

Gentlemen—The importance of the question—"shall models be no longer required?"—must be my excuse for asking your further indulgence for a few lines. I would not ask this much did it not appear that I failed to make myself understood by Mr. Howson, and may have equally failed in other quarters. And in the outset I wish to say to Mr. Howson, that I have too much respect for his age, experience, skill and position to knowingly apply to him any flippant expression whatever, or to impute to him any unworthy motive in the advocacy of any opinion he may hold. When my letter was written and transmitted to you, the authorship of his letter was not known to me.

This subject was opened by the statement in Mr. Baldwin's letter (not Mr. Jno. Baldwin, as your types make me say) that the recent destruction of so large a portion of the Patent Office models has again revived a movement looking to their suppression in patent applications." To this view Mr. Howson, in his reply, says he does not agree. The question with either, is not the possibility of dispensing with models in all cases, for Mr. Howson concedes that, say one case in thirty, may require a model, but the advisability of dispensing with them in any case. For myself, I decidedly am of Mr. Baldwin's opinion, and in my former letter I endeavored to point out some of the practical reasons making models necessary as a rule, and it will be observed that those reasons apply with most force in those cases where the cost of the model would be most burdensome, *i. e*, in complicated machines, such as Mr. Howson concedes would require models. If the model costs but a dollar or two, it is matter of small moment to the inventor whether or not it is required. In such cases both office and attorney could dispense with it; but if the cost is two or three hundred dollars or more, as in many cases, it is a hardship, but it becomes indispensable. For a year or thereabouts models were dispensed with, by order of the Commissioner, in nearly every case so requested; but it was found that the practice was not followed by any practical advantage, or incurred various disadvantages, and it was abandoned; at least I infer such reasons, for I have not made any special inquiries upon the point.

I notice that Mr. Howson does not deny the fundamental ground of my objection to to the abolition of models, *i. e*, that the disclosure of patents must be so complete that a skilled person can, without further invention, construct and work the invention; and that in all cases, and especially of complicated machinery, it will be impossible to arrive at certainty in this regard, unless the drawings are made from a *working machine.* It is perfectly manifest that if, when the skilled person referred to in the law constructs the machine from the drawings and description, he finds, owing to some miscalculation or accidental omission of a part, the apparatus will not go together; there will then be *an end of the patent*, unless a record exists somewhere to which reference can be made for correction. That record must of course be contemporaneous with the patent and above suspicion. *It can best be found in a model deposited in the Patent Office.* It is true a model is not

a part of the patent, but it is a part of the official record of the case to which recourse may at any trial be had for purposes of correction.

The "point" on the part of the objectors to the models is the cost to the applicant, according to Mr. Howson's letter.

The cost of the models is a burdensome tax on inventors; the furnishing of models should not "be compulsory in all cases." "if an inventor is not taxed with the cost of the model, he can afford to pay a reasonable price for carefully performed duties on the part of his attorney." This language is at least susceptible of interpretation, that Peter may be robbed to pay Paul. That the price paid to the model maker may be transferred to the pocket of the attorney. I do not see but that the cost to the applicant would remain the same; and if so, the question recurs, which course will secure the greatest advantage and safety to *the inventor?* An answer which would appear conclusive to me is this:

An applicant will only employ an attorney when unable himself to transact the business satisfactorily. He will therefore rely upon his attorney. *In the absence of means for correction* and error on the part of the attorney may be fatal and irreparable; but no such error can occur if the model has first been made and is deposited in the Patent Office.

I am not familiar with Philadelphia draftmen, but I do know that elsewhere draftsmen, who can design machines of many parts without liability to error in location, etc., are exceedingly scarce. Yet there is no gainsaying the fact that *in the absence* of a model working drawings would be required, and from these all elements of uncertainty must be eliminated, or who could know whether an operative machine was represented or not? Errors will escape the most searching scrutiny, and the greater the complication the greater the chance for such defects, and the denser will be the *cloud upon the patent.* When a machine, either in miniature or otherwise, has been constructed, all sources of discrepancy and error are necessarily eliminated; and when this machine gets into the draftsman's hands his work is plain and straightforward. My remarks, therefore, apply only to those cases where no machine has been made. I venture to say that in twenty-nine out of thirty cases submitted to the official models are built, as I formerly said, piecemeal, and without preliminary studied drawings. This is the only recourse for the great bulk of inventors, who cannot go to Philadelphia or elsewhere in search of a draftsman competent to put the invention down on paper in such a shape as will leave no loop-hole through which the invention may fall out; and after paying for such help, how could he know whether the drawings were correct?

But Mr. Howson would not prohibit inventors from making models if they prefer. We both know that they would often prefer not if it could be avoided, and so far as the office of Mr. Howson is concerned, I am willing to concede that the inventor would be safe; but supposing he applies to one of those gentlemen, whose advertisement is on the same page with his own, Mr. Howson objects to—would he there meet the same candor? It is not probable that the dishonest solicitor would take the same advantage then as now, and with infinitely more disastrous effect, because of the after-correction *without a model.* Is it well to incur that risk?

Many models are constructed under the instructions of attorneys in Washington as well as elsewhere, from drawings and sketches furnished by inventors, and I am personally aware that in such cases, a considerable amount of *controversy* on the part of attorney and model maker is generally required to make things come out right If it were to construct working drawings instead of a model, the care and study required would be greatly increased, it appears that there is a wide difference between an understanding of an inventor, and that *certainty of all the details which must exist somewhere* in order to make validity of the patent sure.

If it is absurd to say that working drawings must be attached to the patent, then it is equally absurd to say that the patent must be a complete disclosure of the invention, for in no other conceivable way can a mechanic, *without invention of his own*, construct and work the device patented. The presence of the model in the case relieves us of the necessity of such complete delineation, because it remains there as the standard by which corrections, at any time found to be necessary, may be made without standard, it would be necessary to be right in the very first instance without any possible uncertainty. That high standard is unattainable.

For the argument's sake I will agree with Mr. Howson, that in twenty-nine out of thirty cases, the model might be dispensed with, but who is to determine as to which is the thirtieth case. I do not see any way more practical than the one now according to law, and I do not see but that it must always be left in the discretion of the Commissioner.

No one doubts the ability of the examiners in the Patent Office, both to read and understand drawings, and we will say that as to them, it is only a question of time, viz: expense. Take a grain binder, loom, knitting machine, or some of the many other machines containing many parts and complicated movements, and no man living can read and understand the invention so quickly nor so accurrately from drawings, howsoever perfect, as from the moving machine. In such cases it would add to the cost of examination; as the examiners themselves estimate from 10 to 50 per cent.

If several examiners never look at the models, I can only say that no one of them has admitted that much to me, and I will venture the guess in regard to them, that it is they who make the greater number of mistakes, and give the greater number of impertnent references—a *bother* to attorneys, which I presume Mr. Howson has not escaped.

In my former letter I said the "New German Patent Law requires models as stringently as ours," in which statement I was correct. If the text of the law is correctly given in the Official Gazette 31st July, section 20, of the law provides that to the application, "the necessary drawings, designs, models and specimens shall be attached," and the Rules provide (O. G. 14, Aug.) Sec. 7: "The subjoining of models and samples is desired, so far as it may aid in giving a clear idea of the invention. It should be done when, without this, the judgment of the application for a patent cannot take place with any certainty."

From which I understand that models may be required or dispensed with at the discretion of the Patent Office, as in this country.

Aside from the reasons which bear upon the proper preparation and probable validity of the patent, there are others in which the visiting public are interested, which in my judgment are entitled to weight. In the formation of a Great National Museum of Mechanics and Arts, if we rely on the contributions of those having successful machines, we shall fail in two respects. 1st, we shall fail to get anything at all from many sources from which highly valuable matter might come, and we shall get many things of little value. It is not every successful man whose care for the public is sufficient to induce him to spend a few hundred dollars on models for the "Museum," while there are many who from vanity or for the sake of notoriety would contribute worthless machines. 2d. we should loose entirely the historical record of the various steps preliminary to the perfected machines, which alone would find its place on the museum shelves.

Respectfully,

R. D. O. SMITH.

TO THE EDITORS OF THE POLYTECHNIC REVIEW:

Gentlemen: In again thanking you for advance proof of Mr. R. D. O. Smith's reply to my last communication relating to Patent-office models, let me in the first place acknowledge the courteous terms in which that gentleman refers to myself, and expressing my belief that after a short practice without models Mr. Smith would view the Patent Office Model System in the same light that I do.

That we must differ for the present is made evident by his rerepeated assertions that, in the absence of models, working drawings will be required.

I, on the other hand, continue to insist upon it that what are known as "working drawings" are not essential, either for attachments to patents, or to enable competent solicitors to prepare applications for patents.

In support of this view I have nothing to add to what I have stated in previous communications. and there is certainly nothing on this subject on Mr. Smith's letter which calls for a reply.

There is one part of his last communication, however, which demands attention; he says: "I will agree with Mr. Howson that in twenty-nine out of thirty cases the model might be dispensed with, but who is to determine as to which is the thirtieth case; and I do not see but that it must always be left to the discretion of the Commissioner."

If Mr. Smith agrees with me that not more than one case out of thirty demands a model, he must certainly admit that it is an act of injustice to tax twenty-nine men because the invention of the thirtieth demands a model.

Four or five years ago the Commissioner of Patents, no doubt observing this injustice, established a rule dispensing with models in such cases as examiners deemed proper; there was such a difference of opinion among examiners, however, as to when models should be dispensed with, some requiring them in all cases, and others in none, that the old unjust system was restored, simply because there was no positive law defining the duties of the Commissioner as regards the demand for models.

The following plan might be adopted, and I may say here that it has been approved of by gentlemen of the highest standing.

Let section 4,891, of Reissued Statutes be repealed and the following added to section 4,889.

"The drawing shall be in every case so full and clear as to enable the Examiners, in connection with the specifications, to understand the invention and to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the invention; if the drawing filed, in any case be deemed insufficient, or if there be a doubt whether the machine or device forming the subject of the application will operate in the manner set forth in the specification, the Commissioner may require the applicant to present a working model, and may also require such additional drawing as he shall deem the case to call for.

In any such case, the model may, after the application has been finally acted on, be returned to the applicant."

Again let the following be introduced between section 4,916 and 4,917.

"In cases of Interference, and in Appeals to the Board of Examiners in Chief, to the Commissioner in person, or to the Supreme Court of the District of Columbia, the party or parties thereto may be required to deposit models for the purpose of illustrating arguments, but in no case shall models be so used unless accompanied by exact drawings of them which drawings shall be filed as exhibits in the records of the case to which they appertain, and after final hearing and adjudication, said models may be returned to the parties depositing them."

Section 4930, to be repealed.

When a specification and drawing are placed before an Examiner and that officer cannot understand the invention after the perusal of these papers, positive proof is afforded that they are not in a proper condition to go before the public as part of a patent.

The Examiner under the suggested law would in such case, have a right to demand a model not to be stored away in the office, but to enable the Examiner to decide wherein the drawings or specification or both, are deficient, and these defects must be *remedied before the case can be acted on*, after which the model may be returned to the applicant.

An Examiner with a model before him, in the first instance, is apt to interpret the drawings by the light which the model affords, and unconsciously passes drawings which he would not recognize as sufficient, in the absence of the model; and the consequence of this is that hosts of patents go out of the office so insufficient that they cannot be easily interpreted without the aid of the model.

Let the Examiner peruse the papers in the first instance, without a model, and if, being an expert, he fails to understand the invention by the aid of the drawings, they are not in a condition to be attached to a patent. He therefore demands a model, and this enables him to judge as to the defects in the drawing, and to insist upon it that these defects shall be remedied before the case is finally acted upon.

Should the plan be carried out we shall have a much better class of patents than we ever had before.

In very many cases Attorneys would make better drawings without models than with them.

There are thousands of models in the Patent Office which are distorted misrepresentations, and as far as decent proportions are concerned, would disgrace the contents of a toy shop, and this is especially the case with miniature model representations of large objects.

These defective models would of themselves be harmless enough, but, unfortunately, the defects appear in the drawings, for it is a rule of the Office that the model and drawings must accord.

Dispense with models and the draughtsman must depend more upon his own experience and skill in making the drawings, which would be more accurate than if he had before him a distorted, misleading model, which the rules of the Office compelled him to follow; and let me say here that there is far more drawing and designing talent in this country than Mr. Smith supposes, and this, if models were dispensed with, would develop itself to the advantage of inventors and the public.

A great portion of Mr. Smith's letter is simply a repetition of the remarks made in his first communication; hence it will be unnecessary for me to follow it closely.

It is stated in substance, that the tricks of dishonest solicitors would have a far more disastrous effect in the absence of models than they have now, "because of the impossibility of after correction without a model."

I presume that Mr Smith intended these remarks to apply, not only to unscrupulous Attorneys, but to those whose incompetency rendered them as dangerous to inventors, as the positively dishonest practitioner.

We cannot legislate rogues from the face of the earth any more than we can legislate brains into the head of an incompetent or stupid man; but if such legislation can be adopted that incompetent and reckless practitioners will no longer find it profitable to continue a slovenly practice, I am sure no one will rejoice more than Mr. Smith.

Nothing can be better calculated to bring about this desirable result, than the abolition of the present model system.

Those who are unwilling or incapable of furnishing the complete drawings and thoroughly prepared specifications which the office will demand in the absence of models, must give way to those who can, and the result will be the dispersion of a lot of incompetent practitioners.

Mr. Smith would have the model system continued because the model affords the means by which a case, butchered by a stupid attorney, may be corrected. I would do away with models in order to do away with stupid Attorneys. I would have an official demand for such complete drawings and well prepared specifications that no alterations would be required.

I do not believe in the continuance of any system which would afford a shadow of encouragement for work so badly executed that it will demand correction after the patent is granted.

Let models be abolished, and the grinding out of hosts of imperfect patents would cease because it would not pay. The profession of soliciting patents would be re-inforced by gradutes from our colleges and technical schools, by men of education, trained to mechanical and scientific pursuits, and by those familiar with industrial pursuits.

We want, in the profession, men who are not only capable and honest, but who will regard the duty of preparing an application as a serious trust.

The abolition of models would not increase the work of honest solicitors who have the intelligence and experience which gentleman like Mr. Smith can bring to bear on every case submitted to them, but it would be disastrous to those who are unfit for the profession.

Mr. Smith's letter instead of shaking has served to strengthen me in my opinions, which may be briefly summarized as follows:

1. The making of models is a serious tax on inventors, involves the premature exposure of inventions, and needless delay in making up applications for patents, and detracts from the revenue of the Patent Office, because the demand for models frequently deters inventors from making applications;

2. Models are not as a rule necessary for attorneys in preparing applications for patents, or for Examiners of the Patent Office in the performance of their duties;

3. With rare exceptions complete well-executed drawings afford more ready means of determining the character of an invention, and should be, in any case admitting of them, sufficient for the interpretation of the specifications forming part of the patent;

4. Owing to the furnishing of models, there is a tendency in the Patent Office to admit drawings which are wanting in fullness and perspicuity, and which would not be admitted in the absence of models, an evil resulting in the delivery of patents which cannot be easily understood without the aid of models.

5. The models deposited in the Patent Office occupy a large amount of space which could be devoted to much more useful purposes;

6. The increase of models must eventually involve the necessity of either disposing of many of them to make room for the rest, or of finding room for the rapidly growing collection in places outside of the Patent Office;

7. The models deposited in the Patent Office are rarely working models, but generally fragmentary, and in many cases distorted representations of the machines they are intended to represent, and are consequently unfit for an industrial museum;

8. That an industrial museum worthy of the name, can be best established by permitting patentees and manufacturers to deposit, at their option and at their own cost, properly proportioned and working models of patented machines which have proved to be successful in practice.

The inconvenience to which solicitors might occasionally be put in the absence of models is quite a secondary consideration, if, as I believe, ends, beneficial to the inventors and the public, will result from the abandonment of the model system, solicitors should cheerfully acquiesce, and accommodate themselves as competent men could easily do, to the altered circumstances.

You have among your subscribers and correspondents many intelligent inventors; let us hear what they have to say on the subject.

I think Mr. Smith will agree with me that it would be but fair to give inventors, who of all others are the most interested in the proposed change, a chance of being heard, before this discussion between solicitors is resumed. Very respectfully,

H. HOWSON.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Franklin Institute.—November 20. The third lecture of the course on "Contrasts and resemblances of Sound and Light," was delivered by Prof. E. Houston. The lecture was a consideration of the properties of transparency to sound and light, as also of the phenomena of reflection of sound and light. The subject was discussed in a clear manner, and the lecturer made use of many interesting experiments to illustrate his remarks. The difference between elastic and non-elastic bodies was shown, and the property of many bodies to convey sound was illustrated; among the experiments shown in this connection was the telephone concert, in which the sound of a musical box and also that of a violin were conveyed to the lecture room from the cellar below by means of a rod of wood. The simple telephone, a stretched wire from sounding box placed in a remote room of the building to a similar box in the audience room, was used. The sound of the voice and that of the cornet were very satisfactorily received in the audience room. The shadow pantomine forms an amusing example of opacity of bodies to light, opacity to sound being seen in non-homogeneous substances. The reflection of sound and light from surface was alluded to, and the analogy between the image seen in a mirror to the sound echo pointed out. Two large concave mirrors, placed opposite each other, were used to exemplify the fact that sound or light waves may be made parallel and collected again at a focus, even at considerable distances. The ticking of a watch placed in the focus of one mirror can be distinctly heard in the focus of the other, and a source of heat similarly used may be caused to set fire to inflammable material, even at a distance of 50 feet or more. E. HILTEBRAND.

ANSWERS TO CORRESPONDENTS.

STRAINS ON IRON SHIPS. (F. S., Chester, Pa.) A ship is a box-girder; hence the bending stress will be inversely as the cube of the length; directly as the breadth; inversely as the depth.

LIFE-BOATS. (T. D., RICHMOND, Va.) These require to be almost non-upsettable; to have speed against a heavy sea; to be easily launched and taken ashore; to immediately discharge any water shipped; to be self-righting, if they do upset; to be strong; and to have large stowage room for passengers. They should be easily rowed in all weathers; not be too heavy to carry on shore; to have suitable fenders, life-lines, etc. If you have one combining these qualities we shall be glad to illustrate it.

OIL FOR DRILLING STEEL. (C. O., Utica, N. Y.) For steel or wrought-iron, use *animal* oil (lard or whale), and not coal oil. Soap and water, or a strong solution of soda, does better than coal oil.

COLD IRON FLOATING ON MELTED IRON. (D. B., Racine, Wis.) A greasy needle will float on water. The solid iron is not necessarily lighter than the same kind of metal melted.

POWER OF ZINC. (G. P. P., Petersburg, Va.) Joule found that a grain of zinc consumed in a battery produced 145.6 foot pounds. A grain of coal produces 1400.

HIGH-PRESSURE STEAM. (C. W. R., Naples, Ill.) The tendency seems to be towards increasing pressures, on the ground of economy.

[OFFICIAL.]

INDEX OF INVENTIONS,

FOR WHICH

LETTERS PATENT OF THE UNITED STATES WERE GRANTED FOR THE WEEK ENDING

November 6, 1877,

AND EACH BEARING THAT DATE.

Those Marked (r) are Re-issued Patents.

A complete copy of any Patent in the annexed list, including both the specifications and drawings, will be furnished from this office for ONE DOLLAR. In ordering, please state the number and date of the Patent desired, and remit to

WAHL & GRIMSHAW, Publishers,
119 *South Fourth Street, Philadelphia.*

	Class No.	No. of Patent
Adz eye tools, die for forging, D. Maydole	49	196,917
Abum, B. J. Beck	146	196,776
Ammonia, process of producing the mono or acid phosphate of, J. E. Siebel	35	196,771
Apple quartering and coring machine, S. Cooper	88	196,743
Axle box, self-oiling, J. Dawber	122	196,789
Barrel machine, J. Naylor, Jr.	40	196,927
Bath, combined, portable hot air and vapor, G. Gordon	8	196,890
Beer cooler, H. Voigt	19	196,956
Belting, machine, C. Kohsel	80	196,911
Boot, E. F. Bickford	15	196,778
Boot jack, J. H. Aufderheide	15	196,857
Bottles, &c., apparatus for stoppering, J. L. Besnard	1	196,867
Bottles, &c., apparatus for stoppering, T. Rule	1	196,936
Brick machine, R. W. Brownhill	20	196,782
Brick machine, M. Hasslacher	20	196,752
Brush, B. R. Hill, Sr.	22	196,852
Butter worker, R. W. Barnard	45	196,859
Can opener, J. P. O. Townsdale	88	196,915
Can or vessel, metallic, C. P. Maxfield	136	196,758
Car coupling, W. Harrison	122	196,896
Car heater, L. T. White	154	196,961
Car, railway box, S. W. Murray	121	196,926
Cars, steam plowing and scraping attachment to, S. T. Shankland	122	196,836
Carbureter, J. Stratton	27	196,946
Cartridge, blasting, A. C. Raud	124	196,767
Chair seat and back, P. Rath	62	196,824
Chandelier, extension, J. F. Brown	64	196,872
Cider mill, portable, L. V. Sikes	19	196,837
Cigar box, H. Meyers	160	196,920
Clothes wringer, D. G. Beers	91	196,777
Coffee and pea nut roaster, C. L. Hall	154	196,964
Corkscrew and extractor, combined, N. Oak	88	196,761
Corset clasp, O. K. Scofield	80	196,940
Coupling and steering apparatus, W. Frick, (re-issue)	137	7,934
Cultivator, H. S. Hoyman	43	196,903
Cultivator, wheel, W. Mettler	43	196,818
Curtain fixture, J. Reichert	62	196,768
Curtain roller and bracket, R. E. Abbott	62	196,737
Ditching machine, G. W. Nevill	51	196,922
Door securer, G. E. Kerlicks	24	196,810
Drawers, men's, H. Borkhim	38	196,780
Elastic fabrics, manufacture of, M. E. Bowra	95	196,871
Electric engineering and lighting system, W. E. Sawyer	50	196,834
Electroplating, compound switch in dynamo electric machines employed in the art of, Weston & Quimby	113	196,846
Feathers for dusters, machine for preparing, G. M. Richmond	22	196,828
Feed water heater and purifier, N. A. T. Jones	148	196,808
Feed water regulator, automatic, Goriti and Unanue	148	196,797
Fence post, E. L. Gillham	52	196,889
Fence post, iron, McNeill and Lambert	52	196,816
Fire arm, breech-loading, V. Bovy	18	196,781
Fire arm, breech-loading, G. H. Fox	18	196,748
Fire kindlers, composition for, W. McArthur	154	196,918
Fireplaces, fender for, H. Adler	154	196,738
Fire pot and water heater, combined, E. P. Doyen	147	196,884
Fireman's helmet and dress, J. Bechtold	38	196,862
Floor, fire-proof, E. Gleason	4	196,750
Flower pot, W. F. Russell	63	196,937
Fluting iron, J. H. Cleveland	91	196,878
Furnace grate, T. James	154	196,905
Furnaces, attachment for feeding straw to, L. C. Taber	148	196,839
Furnaces, automatic fuel feeder for, R. Morgan	148	196,924
Furnaces, device for feeding air to boiler, H. F. Hayden	148	196,897
Gas burner, W. G. Pugh	64	196,931
Gas burners, reflector for, W. E. Prall	64	196,765
Gate, farm, C. A. Mosher	52	196,925
Gearing, friction, D. H. Merritt	67	196,817
Glass labels and apparatus therefor, making, P. Arbogast	68	196,855
Governor for steam engines, &c., E. A. Sutcliffe	69	196,947
Grain, apparatus for scouring and polishing, M. D. Beardslee	57	196,860
Grain band, W. A. Sutphin	74	196,950
Grain binder, W. A. Sutphin	74	196,949
Grain binder, C. B. Withington	74	196,775
Grain separator, J. L. Booth	159	196,779
Gun, double-barreled, Fox and Wheeler	55	196,749
Harness breast strap, A. G. Ritz	72	196,935
Harrow, R. Mitchell	73	196,921
Harvester cutter, C. N. Swart	74	196,952
Hat-pressing machine, H. A. Jamieson	76	196,755
Hay elevator and carrier, C. Kistner	79	196,910
Hinge, Fabnestock and Peckham	24	196,791
Horse power, J. H. Elward	159	196,887
Horses and cattle, condition powder for, J. H. Marshall	98	196,916
Horseshoe nails, machine for finishing, S. S. Putnam	60	196,932
Hose and pipe coupling, Jolliffe and Schneider	81	196,807
Hose coupling, S. Ingersoll	81	196,904
Inhaler, J. Lewis	156	196,812
Inlaid work, machine for making, E. Jebsen	54	196,906
Ironing machine, P. O'Thayne, (re-issue)	91	7,936
Ironing machine, P. O'Thayne, (re-issue)	91	7,937
Knob screws, guard for door, C. M. Baker	93	196,858
Knobs, attaching shanks to door, A. E. Young	93	196,852
Lamp, L. H. Olmsted	90	196,762
Lamp burner, F. Holt	90	196,901
Lantern, A. M. Duburn	90	196,885
Latch for car doors, J. Capron	93	196,741
Leather straps, attaching device for, T. H. Sabin	92	196,939
Life boat, T. W. Casey	13	196,874
Lightning rod, L. Adams (re-issue)	50	7,939
Lock, bolt, E. J. Lockwood	93	196,914
Lubricator, F. Collignon	87	196,742
Matches for dipping, preparing, P. Beer	71	196,864
Meats, preserving, M. and L. Ottenheimer	58	196,929
Mechanical movement, W. A. Sutphin	67	196,951
Mechanical movement, A. S. Todd	67	196,842
Mercury as a motive power, utilizing, T. D. Miller	2	196,759
Metals, separating, C. Wiegand	99	196,848
Milk cooler, C. G. Riggs	45	196,829
Mill gearing, G. W. Schreurs	57	196,835
Millstone dress, E. D. Speer	57	196,944
Millstone driver, J. Planck	57	196,930
Musical instruments, key for, J. P. Lord, (re-issue)	102	7,935
Nail machine, cut, J. A. Bidwell	103	196,869
Napkin ring and holder, J. Heberling	88	196,898
Nippers, car ticket, J. Thomas	146	196,841
Overalls, L. Aronson	38	196,856
Packing case, J. I. Berry	88	196,866
Paddle wheel, H. Marcotte	139	196,813
Pail, scrubbing, F. N. Burk	40	196,783
Paper dish, Crume and Aulabaugh	109	196,880
Pen, stencil, T. A. Edison	146	196,747
Phosphates, treatment of mineral, P. G. L G. Designolle	96	196,881
Piano action frame, Kranich and Bach	112	196,912
Piano fortes, stringing device for, J. D. Elliot, (re-issue)	112	7,933
Pipe Coupling, E. S. Chapell	167	196,875
Pipe elbow seaming machine, G. Choate	136	196,785
Pipe, water supply, C. L. Driesslein	167	196,745
Planing machines, chip breaker for, E. Benjamin	175	196,739
Plant setter and seed planter, combined, J. C. Terrill	133	196,840
Planter and grain drill, sulky corn, T. Terry	133	196,954
Planter, corn, H. Jones	133	196,908
Planter, corn, S. Rydbeck	133	196,938
Planter, cotton, J. W. Elliott	133	196,886
Planter, cotton, D. W. Reed	133	196,933
Planter, cotton seed and corn, J. R. Palmero	133	196,823
Planters, check row attachment for corn, E. M. Wilcox	133	196,849
Plastic composition apparatus for mixing, A. Dietz	110	196,882
Plate lifter, W. Beattie	88	196,861
Plow, R. Coreth	114	196,744
Plow, J. and M. Rich	114	196,934
Plow, M. Turley	114	196,774
Plow, harrow, and seeder, combined, J. Hoffacker	114	196,899
Plows, cultivators, &c., draft attachment for, T. W. Lerch	114	196,756
Pocket book and revolver, combined, O. Frankenau	146	196,794
Potato bug gatherer, H. Charles, Jr.	63	196,876
Potato digger, H. More	114	196,760
Pulley, counter shaft, G. Soger	79	196,772
Pulp engine, S. L. Gould	108	196,752
Pump, force, J. Tallent	118	196,953
Quilting machine, A. Beck	38	196,986
Railroad track, L. Hall, (re-issued)	120	7,941
Rein holder, G. Jennings	31	196,866
Rock drill, U. Cummings	124	196,788
Roofing tile, H. Stripe	126	196,773
Roundabout, H. H. Hawthorne	143	196,753
Roving frame, worsted, H. N. Craven	142	196,787
Sad iron, L. Passmore	91	196,763
Sash fastener, W. P. Hudson	24	196,803
Sash holder, R. B. Hugunin	24	196,804
Saw, C. J. Wilson	131	196,850
Saw frame attachment, G. W. Higgins	131	196,801
Saw teeth, machine for forming insertible, W. Hawkins	131	196,800
Saws, hanging circular, F. Hamilton	130	196,893
Saws, tension attachment for scroll, J. R. Vallacott	130	196,955
Sawing machine, scroll, J. Glover	131	196,796
Scales, weighing, C. L. Bellamy	132	196,865
Scoops, making wooden, R. Richardi, (re-issued)	175	7,940
Screw tap, J. Crok	14	196,879
Sewing machine, wax thread, J. Keith	134	196,809
Sewing Machines, embroidering attachment for, Rose and Somers	134	196,769
Sewing machines, feed mechanism for, T. K. Keich	134	196,909
Shaft couplings, clutch for, A. A. Osborn	87	196,822
Shaft holder, vehicle, W. H. and J. A. Froman	31	196,888
Shaft tug lining, E. C. Bickford	72	196,868
Shafts, bearing for, L. T. Jones	87	196,907
Shoe, M. How	16	196,754
Shuttle motion, E. H. Graham	95	196,795
Skins, machine for scouring and dressing sheep and goat, C. T. and S. A. Ford	92	196,793
Skylight, F. M. Campbell	30	196,784
Soap, floating, A. Quentin	26	196,766
Spoke socket, G. F. Graves	31	196,891
Staves, machine for chamfering and crozing, B. W. Sutherlen	40	196,948
Steam engines, compound condensing apparatus for, J. Houpt	152	196,902
Steam generator, Renshaw and Tower	147	196,825
Steam trap, C. F. Pike	150	196,764
Stilts, adjustable, C. S. Shute	143	196,941
Stirrup, H. M. Hollingsworth	72	196,900
Stove, warming, R. E. C. Divver	154	196,883
Sulphuric acid, apparatus for purifying and condensing, R. W. Wallace	47	196,957
Surgical bandages, apparatus for preparing, F. Green	156	196,892
Tablet, grave, F. C. Bushway	146	196,740
Telegraph instrument, autographic, W. E. Sawyer	50	196,832
Telegraphy, device for effecting the static discharge in autographic, W. E. Sawyer	50	196,833
Time detecter, watchman's, W. W. LeGrande	36	196,913
Tin, manufacture of oxide of, J. M. Sanders	136	196,831
Tire bending and upsetting attachment for punching and shearing machines, A. W. Comstock	31	196,877
Tire upsetter, J. G. Mole	31	196,923
Tobacco, device for drying and conditioning leaf, R. Dunlop	160	196,746
Tombstones, &c., device for depositing and covering pictures in, J. D. McClain	39	196,919
Torpedo for oil wells, C. A. McCoy	124	196,815
Toy money box, J. H. Bowen	143	196,870
Toy scroll sawing machine, S. N. Trump, (re-issue)	143	7,938
Toy whirligig, C. E. Steller	143	196,838
Track lifter and spike puller, combined, J. S. Kirkwood	79	196,811
Tracton wheel, W. H. Trenwith	94	196,843
Transom lifter, J. F. Wollensak	30	196,851
Treadle, H. Shogren	67	196,770
Truss, L. Westinghouse	156	196,959
Tube machine, McC. Young	163	196,853
Tucker, E. A. Vance	38	196,845
Twine holder, A. J. Morrison	24	196,819
Type-setting machine, Reynolds and Thorne	117	196,826
Umbrella holder, A. T. Martin, Jr.	162	196,814
Valve, cut off, T. Whittaker	152	196,847
Vehicle seat, F. Oppenheim	31	196,821
Vehicle, side spring, Magner and Thomas	31	196,757
Vehicle, spring, F. Oppenheim	31	196,820
Vehicle wheel, C. E. Bush	31	196,873
Velocipede, Smith and Thurston	31	196,943
Ventilator, smoke, C. K. Edwards	166	196,790
Vessels, buoying, J. C. Wheeden	137	196,960
Violins, chin rest for, H. W. White	102	196,962
Vise, anvil, A. H. Anderson	60	196,854
Vulcanized fiber, manufacture of, T. Hanna	84	196,895
Vulcanized fiber, manufacture of water-proof, T. Hanna	84	196,894
Wagon tongue support, J. M. Hunter	31	196,805
Wash bowls, tubs, baths, &c., overflow and discharge		
Washing machine, Harrington and Stoddard	91	196,799
valve for, H. Ogden	8	196,928
Watch-case spring, A. N. Clark	36	196,786
Water closet, N. Folsom	8	196,792
Water closets, porcelain bowl for, C. Harrison	8	196,798
Water meter, D. P. Weir	167	196,958
Water tube boiler, C. Tyson	149	196,844
Wheelbarrow, W. H. Stevens	31	196,945
Whip and cane handle, W. H. Rice	72	196,827
Whip socket and line holder, A. Smith	31	196,942
Wire-drawing machine, J. S. Winsor	163	196,963
Wire stretcher, C. F. Roth	52	196,820

THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, DECEMBER 15, 1877. No. 24.

IMPROVEMENT IN BOARD-CUTTING AND SEASONING MACHINES.

Doubtless few of our readers have taken the trouble to calculate the exact amount of waste in lumber sawing, owing to the excessive quantity of material destroyed in the "kerf" or cutting line of the saw. Generally, this is entirely wasted; although the huge piles of sawdust are sometimes utilized as fuel. The following calculations, however, will serve to show the waste in sawing up a log 24″ square, respectively with a circular saw cutting ¼″ kerf, a mulay or sash saw with a ⅛″ cut, and a veneer saw taking only a $\frac{1}{16}$″ cut. (Generally we may say that a circular saw cuts a ¼″ to ⅜″ kerf, a mulay or sash saw ⅛ full; band-saw for lumber (not a scroll saw,) $\frac{1}{12}$ to ⅛, and veneer saw $\frac{1}{16}$ to $\frac{1}{12}$.)

TABLE I.

Thickness.	Kerf in Inches.	Thickness of Board & Kerf.	Number of Boards.	Number of Saw-cuts.	Feet of Lumber in Kerf.	Feet of Lumber one inch Measure.	Percentage of Waste to Log.
1	¼	5/4	19	18	20	76	20.83
	⅛	9/8	21	20	12	84	12.50
	$\frac{1}{16}$	$\frac{17}{16}$	22	21	8	88	8.33
½	¼	¾	32	31	32	64	33.33
	⅛	⅝	38	37	20	76	20.83
	$\frac{1}{16}$	$\frac{9}{16}$	42	41	12	84	12.50
¼	¼	½	48	47	48	48	50.00
	⅛	⅜	64	63	32	64	33.33
	$\frac{1}{16}$	$\frac{5}{16}$	76	75	20	76	20.83
$\frac{1}{16}$	¼	$\frac{5}{16}$	76	75	77	19	79.16
	⅛	$\frac{3}{16}$	128	127	64	32	66.65
	$\frac{1}{16}$	$\frac{2}{16}$	192	191	48	48	50.00

In making the calculation on the sawing, only a sixteenth is deducted for saw kerf, and a sixteenth for planing, an allowance only reached under favorable circumstances, the average being still greater.

Table I. shows the per cent. of economy of the veneer and band saw over the circular in sawing the various stuffs.

The following is a statement of the comparative difference between sawing and cutting thin lumber, showing the enormous waste in sawdust and planing by the former method, and the gain through the latter.

TABLE II.

1000 ft., if cut ½ inch thick, produces	2000 feet.		
do. do. if sawed and planed to ½ inch, produces	1600 do.	Gain 400 ft.	25 per ct.
do. do. if cut ⅜ inch thick, produces	2666 do.		
do. do. if sawed and planed to ⅜ inch., produces	2000 do.	Gain 666 ft.	33⅓ per ct.
do. do. if cut $\frac{5}{16}$ inch thick, produces	3200 do.		
do. do. if sawed and planed to $\frac{5}{16}$ in., produces	2286 do.	Gain 714 ft.	40 per ct.
do. do. if cut ¼ inch thick, produces	4000 do.		
do. do. if sawed and planed to ¼ inch, produces	2667 do.	Gain 1333 ft.	50 per ct.
do. do. if cut $\frac{3}{16}$ inch thick, produces	5333		
do. do. if sawed and planed to $\frac{3}{16}$ in., produces	3200 do.	Gain 2133 ft.	66⅔ per ct.
do. do. if cut ⅛ inch thich, produces	8000 do.		
do. do. if sawed and planed to ⅛ inch, produces	4000 do.	Gain 4000 ft.	100 per ct.
do. do. if cut $\frac{1}{16}$ inch thick, produces . . .	16,000 do.		
do. do. if sawed and planed to $\frac{1}{16}$ in., produces .	5333 do.	Gain 10,667.	200 per ct.

Average gain 1 $\frac{1}{16}$ to ½ inch. 73½ per cent.

We must also consider that in running ¼″ kerf it takes double the power required for the ⅛″, and four times that for the $\frac{1}{16}$″ kerf; another important item.

A further matter for consideration is that there must nearly always be removed from each side of each sawed board, by planing, a certain thickness of material, say $\frac{1}{64}$″ as a minimum, from each surface, or $\frac{1}{32}$″ in all. This must be taken from the gross amounts of boards realized as shown in Table I.; giving us the following as the net results from a 24″ square log.

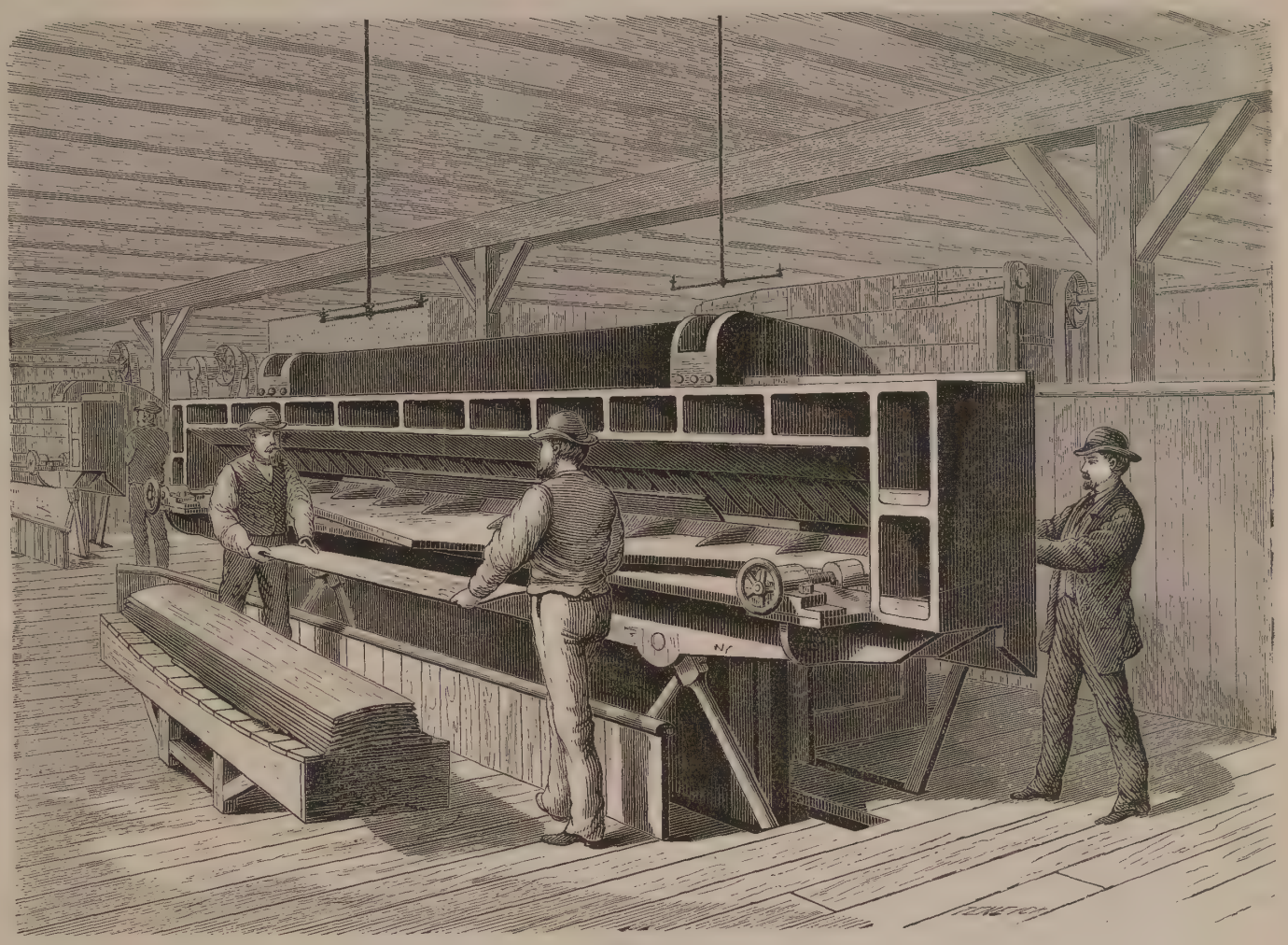


Fig. 1.

TABLE III.

Stuff.	Total Feet rough 1-inch Measure.	Removed in Planing.	Net.	Net per cent. of Log Realized.
1	76	2⅜	73⅝	76.69
	84	2⅝	81⅜	84.75
	88	2¾	85¼	88.80
½	64	4	60	62.50
	76	4¾	71¼	74.22
	84	5¼	78¾	82.03
¼	48	6	42	43.75
	64	8	56	58.33
	76	9½	66½	69.27
$\frac{1}{16}$	19	9½	9½	9.89
	32	16	16	16.66
	48	24	24	25.00

There is not only wood, but power and time and interest on investment, concerned in planing. This item, like that of waste from kerf is especially heavy in circular or mulay sawing, and with thin boards, requiring the removal of $\frac{1}{16}$″ of wood on each side of the board, or ⅛″ in all, to take out the saw-marks.

Figuring up the planing waste on this latter basis, the average loss would be nearly twice that indicated by the table.

We illustrate in Fig. 1 a machine* which cuts boards smoothly and without any waste. The log is held stationary while *sliced* with a knife with a drawing cut, similar to that employed by printers in trimming paper and cardboards. The cut, height of the table, etc., are adjustable; and it is stated that, with three men to tend the machine and two to prepare logs, the machine can produce, from square or round logs, 280,000 feet of veneer, or say 50,000 feet of veneer, 20,000 to 25,000 feet of ⅛ to ¼ inch, and 10,000 of ½ inch stuff; in all cases the grain being firm and unbroken, and in the matter of smoothness of surface requiring no further preparation for use.

* Patented by H. T. Bartlett. Owned and operated by George W. Read & Co., 200 Lewis St., N. Y.

The disadvantages of the ordinary kiln-seasoning are the length of time required, and the checking and warping of the lumber. The great space needed for air-seasoning is a great disadvantage, and the time required is greater than with the common kiln.

The steam press* shown herewith obviates the use of the dry kiln, and will "season" the lumber in from two to twenty minutes. There is a series of steam-heated chambers with continuous circulation, and connected by steam pipes having joints permitting vertical motion in the boxes. Steam is used at a pressure of about 75 lbs., corresponding to a temperature of 311° F. The distance between the boxes may be adjusted to suit the thickness of material. The boards are inserted between the boxes, and the whole is forced together by hydraulic or steam pressure. The sap in the wood is driven off in vapor, which escapes through channels in the faces of the chambers, or in the "liners" generally employed. We are informed that an unseasoned and just-cut cedar board, 11¼" wide, ¼" thick, and weighing four pounds, was, after being in the press five minutes, reduced to 11⅛" in width and 2½ lbs. in weight.

We regard these machines as of the first importance in wood-working economy.

G.

*Owned and operated by Geo. W. Read & Co., 200 Lewis St., New York.

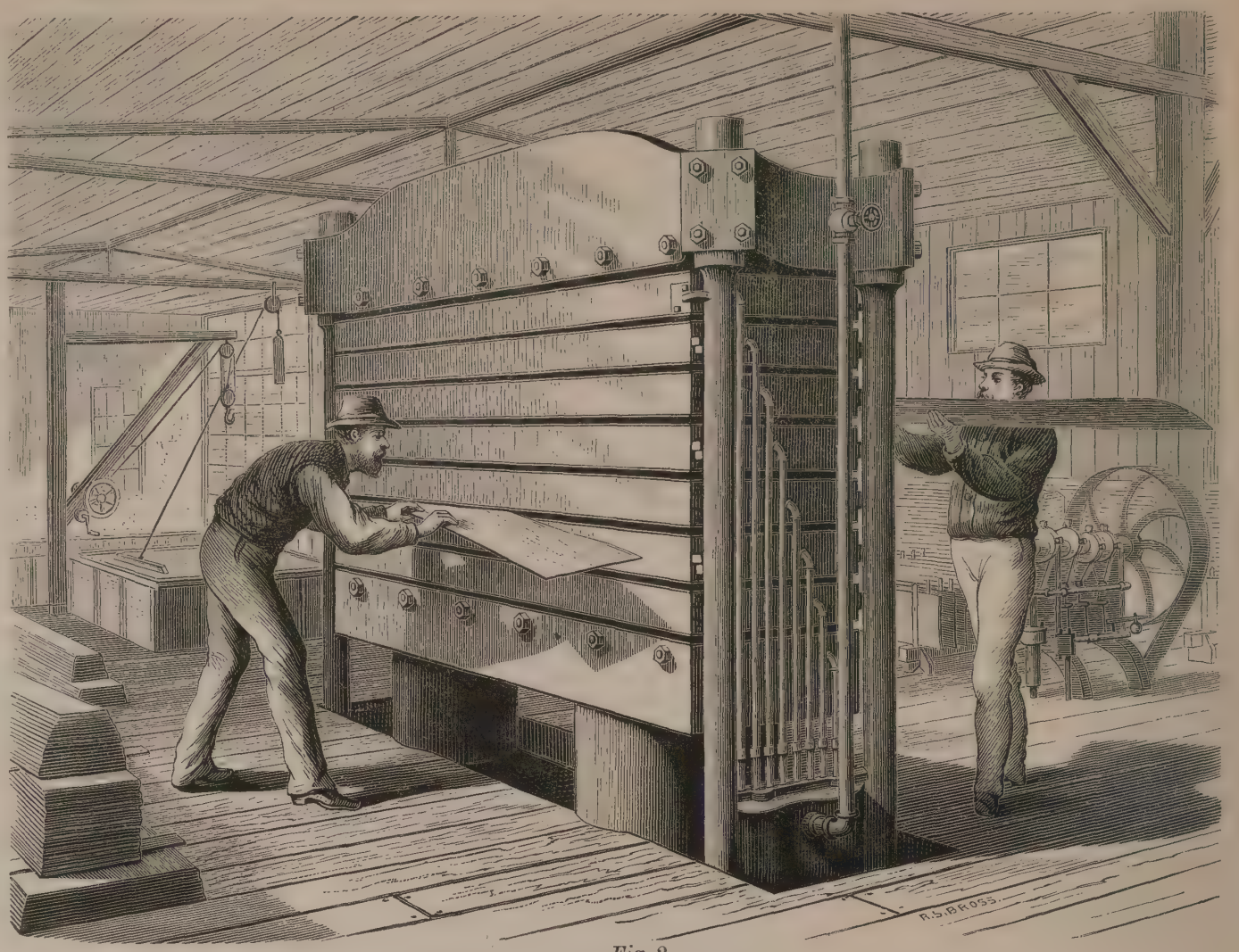


Fig. 2.

HOW AXES ARE MADE.

The common or "Yankee" axe is too well known and used to require any description, but a brief account of the process as practised by a well-known firm* may not be without interest. In different localities different weights of axes are used. The lightest are those commonly used in the household, while the lumbermen of Maine and Michigan demand a much heavier implement, and those affected by the Californian and Australian are the heaviest, seldom weighing less than seven pounds. Then there are post axes for cutting the holes for rails in the posts of the ordinary rail fence, turpentine axes for nicking the pine to gather the sap, and some are made double-bitted, having both ends edged. Those which are sent to the South American markets have no head or "poll," the handle being received into an aperture formed simply by bending the iron into a ring to form a socket. The steel is made from bars of Danemora iron from the region of Upsala, Sweden, the bars having a cross section of about three inches by five-eighths of an inch. These bars, to the amount of about twelve tons, are packed with broken-up charcoal in an oven, or cementation furnace, luted air tight, and heat is supplied from the burning of bituminous coal for a period of from twelve to fourteen days. When taken from the oven the bars are covered with blisters, from whence the name of blistered steel, a material well known to blacksmiths of the last generation, who used it for the "laying" of axes and other purposes, refining it by successive heatings and hammerings. When withdrawn from the ovens and cooled, this blistered steel is as brittle as glass. It is then broken in pieces and melted in plumbago crucibles, holding something above fifty pounds each. It is cast in moulds of cast iron, made in halves and secured by iron clamps, the ingot being in the form of a cylinder about three and a half inches diameter. The waste by oxidation in melting is seldom more than two ounces in fifty pounds. Soon as poured the metal begins to cool, and if it is of the right "humor," it forms at the top a conical depression. If there is no depression, or shrinkage, the whole ingot is honey-combed, and no amount of heating and hammering can render it homogeneous; it is fit only for breaking up and re-melting. The good ingots are treated to a thorough heating and hammering previous to passing through rolls to form them into bars of convenient size for the axe bits.

Formerly the polls or heads of axes were made by drawing down a bar of iron from the middle each way, leaving the thick part for the head, the thin portions forming the eye and the embracing flaps for the reception of the steel bit. But it was found that the welded portion below the eye was liable to split in use.† The present method is to form the poll from a solid bar of iron. This is done by a machine that operates two punches simultaneously to form the eye for the reception of the handle. The attendants of this machine take the bar and, after heating it, place it under shears that cuts off a piece just sufficient for the poll, which piece is placed in the machine, the two punches working from either edge, a supplementary punch finishing the eye and a set of dies forming the sides, when the poll drops, still red-hot, ready to receive the bit. There is no welding around the eye by this method, and consequently no danger of producing a "cold-short." The after insertion of the steel bit and shaping the axe are done by ordinary forging.‡

The axes are then sent to the hardening and tempering room, which is partially darkened, so that no ray of sunlight is admitted to mislead the workman, who depends entirely on the sense of sight for the perfection of his work. The hardening ovens are circular, having a vertical shaft in the centre to which are attached rotating tables, on which the axes are laid with the bits toward the outside. The table turns slowly but continually, bringing the axes over furnaces of anthracite coal alternating with spaces. When brought to the proper redness by heat, the axes are hung on hooks on a revolving frame, the bits dipping into a tank of brine, which is kept in constant circulation by a pump. When cool, the axes are brittle and must be tempered, which is done by heating them in a rotary oven like that used for the hardening, except that the fuel used is charcoal. One of the batch of perhaps two hundred which are tempered, or drawn, at one time is brightened, and serves as a test of all the others, the rotary action of the shelves insuring equal heating. When the brightened axe shows the right color, the entire batch is removed, and are then ready for subsequent finishing operations of grinding and polishing. One axe out of each batch is broken after tempering to test, not only the temper, but the quality of the steel. The grinding is done on Nova Scotia stones from six to seven feet diameter.

J. H. L.

*The Collins Axe Company, Collinsville, Conn.

† Nearly all the axe makers, except the Collins Co., still do this—rolling the blank and turning and welding the poll—but it is a faulty process.—EDS.

‡ The Collins Co. only do this, using patented machines and processes invented by E. K. Root, years ago. This is is known as the Root or Collins Co.'s method of making *solid* punched polls. Messrs. Morrison, Calwell & Page, of Cohoes, N. Y., now make in so-called Blake machine punched polls and sell to the trade.—EDS.

BELTING.*

WHY A BELT RUNS TO THE HIGHER PART OF A PULLEY.

Much disputation has been published in efforts to solve the question: Why does a belt run to the higher part of a pulley? There may be several causes, but the chief one is embodied in the following words: "That end of the belt which is towards the larger end of the cone is more rapidly drawn than the other edge; in consequence of this the advancing part of the belt is thrown in the direction of the larger part of the cone, which obliquity of advance towards the cone must lead the belt on its higher part."

"It may here be observed that this very provision—the rounding of the face of the pulley—which keeps the belt in its place so long as the machinery is in proper action, tends to throw it off whenever the resistance becomes so great as to cause a slipping."

"To maintain a belt in position on a pulley, it is necessary to have the advancing part in the plane of the wheel's rotation."

SUPERIORITY OF THE DRIVING-BELT.

"There is no simpler or smoother means of communicating motion than that afforded by the noiseless agency of cords, bands or straps. The very means by which the motion is maintained—namely, by the frictional adhesion between the surfaces of the belt and the pulley—is a safeguard to the whole mechanism, as, if any unusual or accidental obstruction should intervene, the belt merely slips, and breakage and accident are thus prevented."—*London Mech. Mag., March*, 1863.

"The facility with which this communication of rotary moti on may be established or broken at any distance, and under almost every variety of circumstance, has brought the band so extensively into use in machinery, that it may be considered as one of the principal channels through which work is made to flow."—*Moseley.*

ANOTHER "FIVE-DOLLAR" IDEA.

I believe it is not generally well known that steel tools sprung in hardening can be straightened in tempering. Hardened steel, when not enough to change the color to straw color or purple, is about as pliable as annealed steel when cold. So pieces warped in hardening can, while hot, be straightened with a hammer, or, better, with a screw-press, without danger of breaking.

J. E. S.

* Extracted from "The Use of Belting," by J. H. Cooper, M. E., (Claxton, Remsen & Haffelfinger, Philadelphia, Publishers.)

WARMING AND VENTILATING—I.

[The following paragraphs are abridged from, or based upon, the French of General Morin. The cuts are kindly loaned by the Smithsonian Institution.]

Heating apparatus should be economical of fuel, healthful and comfortable. For places occupied but for short periods (vestibules, stairways, churches, &c.,) the first should be the leading consideration. For constantly occupied buildings the second should have more weight. Every heating apparatus or system which does not either provide in itself for an ample and regular change of air, or connect with some such means, is unhealthful. The third point is allied to the second.

At the head of comfortable forms are open fire-places, either ordinary or ventilating. Some ordinary open fire-places have a chimney with narrowed throat connecting with the hearth (Fig. 1), and with a brick or tile shaft, or a terra-cotta cap (Fig. 2);

Fig. 1.

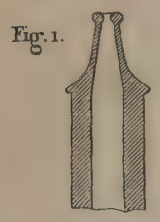


Fig. 2.

the opening for smoke escape being narrow than the main flue section. This is almost like the type which Rumford laid stress upon, but did not point out the correct proportions. In a second type (upper stories of Parisian houses,) the flue (generally cylindrical,) has the same sectional area throughout. Peclet recommends it, but it should be restricted to very small chimneys, and for heating purposes only, the ordinary fire-place, receiving large amounts of air from apartments, are healthful when the air is not supplied by cold external air, through cracks in chimneys, doors, &c. There are cases (especially where weather-strips are used,) where the new air is supplied through kitchens or water-closets; this is most unhealthful. The hot air escapes at 140° to 212°, wasting $\frac{6}{7}$, $\frac{7}{8}$, or more of the heat, so that the heating effect is but 12 to 14 per cent. of that in the fuel; hence the incoming air should be limited sufficient to maintain healthful condition and proper force of draft. A common Parisian chimney removes in an hour an amount equal to five times the capacity of the room; in usual sized rooms securing over 1,000 cu. ft. of air per hour for each person (supposing there to be more than one for every 10 sq. ft. of floor room). For the draft to be strong enough and unaffected by the wind, 10 ft. a second is sufficient velocity for the products of combustion in an ordinary fire; but such velocity in the main flue is unnecessary and injurious, 3 to 7 ft. being enough; this being secured by making the flue large enough.

For private houses of moderate height, having walls sufficiently thick, the chimneys may be of common brick, and of the proportions given in the following table:

Area of room.	Volume of air to be changed every hour.	Flues.				Shafts.			
		Sectional area.	Rectangular. Length.	Rectangular. Breadth.	Cylindrical diameter.	Sectional area.	Rectangular. Length.	Rectangular. Breadth.	Cylindrical diameter.
Cubic ft.	*Cubic ft.*	*Sq. in*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Sq. in*	*Ft. In.*	*In.*	*Ft. In*
3,532	17,658	144	1. 2, 9-16	0. 9,13-16	0.11,1-2	72	1. 1	5,1-2	0. 7,1-2
4,226	21,189	172	1. 2, 9-16	0. 11,13-16	0.11,3-16	86	1. 2, 9-16	5,7 8	0. 8,1-4
5,296	26,487	213	1. 6,1-8	0. 11,13-16	1. 1	108	1. 1,11-16	8	0. 9,7-8
6,356	31,784	258	1. 9.5-8	0. 11,13-16	1. 2,1-2	129	1. 4,1-8	8	0. 10,3-16
7,769	38,847	316	1. 10,13-16	1. 1,11-16	1. 3,3-4	158	1. 7,11-16	8	0. 11,3-16
10,382	45,910	373	1. 11,13-16	1. 3,3-4	1. 5,5-16	186	1. 11,5-8	8	1. 0,3-16
10,595	52,973	430	2. 2	1. 3,3-4	1. 6,1-2	215	1. 11,5-8	9	1. 1

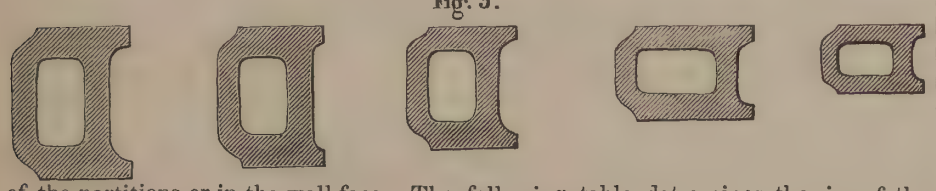
The sizes given for rooms of 10,000 cubic feet are large, and could not well be exceeded without that first annoyance of large flues, descending currents of smoke when the fire is kindled.

When houses are of many stories, or "flats," chimneys may be of bricks of sperical forms or of pottery-pipes,capped with cylinders of the following dimensions:

Number of Pattern.	Diameter.	Sectional area.
	Inches	*Sq. in.*
1	9, 13-16	76
2	8, 11-16	59
3	7, 1-2	44
4	6, 5-16	31

The pottery-pipes are of three types: (1) wagons (Fig. 3) placed in the thickness

Fig. 3.

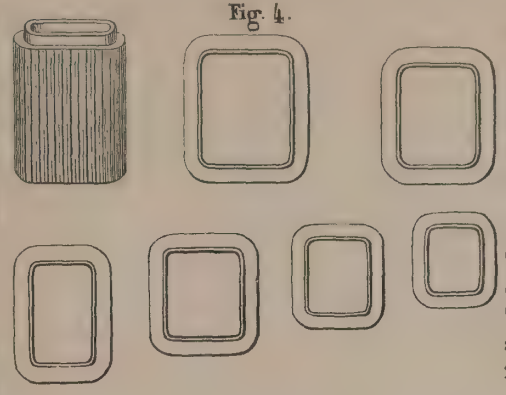


of the partitions or in the wall-face. The following table determines the size of the pipe and cap:

Capacity of room.	Thickness of walls.	Number of pattern.	Internal dimensions. Length.	Internal dimensions. Breadth.	Sectional area of flue, A.	Number of corresponding cap.	Sectional area of cap, A'.	Ratio of $\frac{A}{A'}$.
Cubic Feet.	*Ft. In.*		*Ft. In.*	*Ft. In.*	*Sq. in.*		*Sq. in.*	
3,532–4,944	1.7,11-16	1	1.1,1-4	0.8,1-4	111	1	76	1.45
2,825–3,532	1.4,1-2	2	0.11	0.8,1-4	91	2	59	1.54
2,825–3,532	1.3,3-4	3	0.10,3-16	0.8,1-4	85	2	59	1.43
2,825–3,532	1.1,3-8	4	0.10,5-8	0.8,1-4	88	2	59	1.49
1,589–2,119	0.9,13-16	5	0.7,7-8	0.7,1-16	51	4	31	1.78
								1.54

The second type of pipes in sections called measures (Fig. 4), are for chimneys projecting from the wall against which they are built. They are thin; their mean height 21 inches. Table 4 shows the proper size. Of course, these pipes are for rooms only of ordinary size, and are too small for large reception rooms.

Fig. 4.

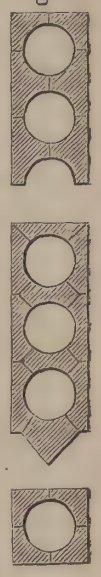


The third type of pipe, (called Gourlier's), is arch-shaped, (see Fig. 5). These pipes are used only for small chimneys, or where stoves are used. The sections are molded in *voussoirs*, and four form the flue, usual thickness $2\frac{3}{4}$ inches. There are two patterns—

Size of place to be warmed	Number of pipe.	Internal dimensions. Length.	Internal dimensions. Breadth.	Area of flue A.	Number of corresponding cap.	Sectional area of passage A.	Ratio $\frac{A}{A'}$
Cubic Feet.		*Inches*	*Inches.*	*Sq. in.*		*Sq. in.*	
3,532–4,944	1	11,13-16	9,13-16	116	1	62	1.53
2,825–3,532	2	9,13-16	8,11-16	85	2	59	1.44
2,119–2,825	3	9,13-16	6,5-16	62	3	44	1.42
2,119–2,825	4	8,11-16	7,1-2	65	3	44	1.48
1,589–2,119	5	7,1-2	6,11-16	51	4	31	1.62
	6	6,5-16	5,1-8	32			1.50

one having a passage $9\frac{13}{16}$ inches diameter (76 square inches area) and designed for walls $19\frac{11}{16}$ inches thick; the then $8\frac{11}{16}$ inches diameter internally (59 square inches) for $15\frac{3}{4}$ inch walls. These flues can secure ventilation in very small rooms only; should not be capped; are limited in use to rooms warmed with stoves.

Fig. 5.



Ventilating fire places are specially designed to ventilate without wasting as much heat as the ordinary open fire-place. This they accomplish by introducing fresh air, considerably warmed, to replace that taken up the chimney with the draft. While the first plans scarcely drew in $\frac{1}{10}$ of fresh air, and raised that to 200° or 250°, the forms devised by Capt. Douglas Galton for English barrack use are highly satisfactory.

Figs. 6, 7, 8, 9, 10, show them to consist of an ordinary wood or coal grate, completely separated from the wall behind; the flue (as far as the top of the room to be warmed) is a cast-iron pipe in the centre of a shaft extending to the ceiling; and into this outer pipe or shaft passes the external air, admitted from below at side or back, as convenient. Near the ceiling this shaft has an opening with inclined slots directing the air upwards. This opening contains a register to be regulated as the fire is bright or dull. The amount of air thus discharged into the room at 80° differs but very little in volume from that passing up the chimney; so that the admission of cold air through cracks is almost prevented. The warm air increases the heating effect of the fire-place to almost 35 per cent.; (the common forms having

Fig. 6

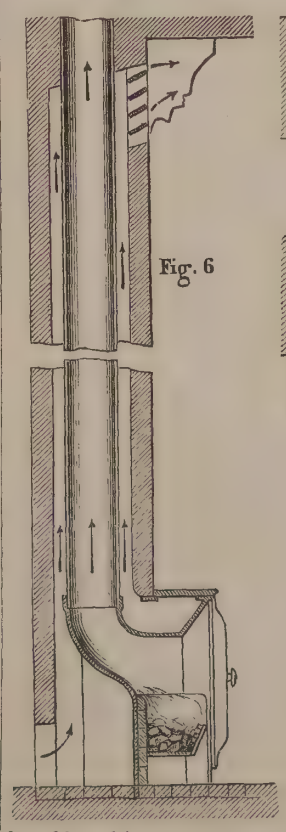


Fig. 7

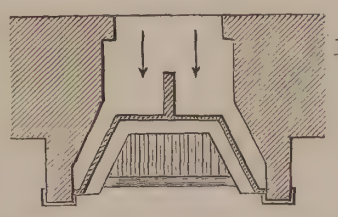


Fig. 8

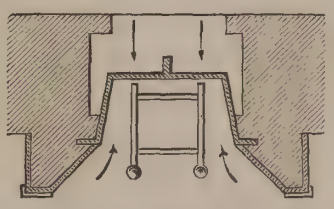


Fig. 9.

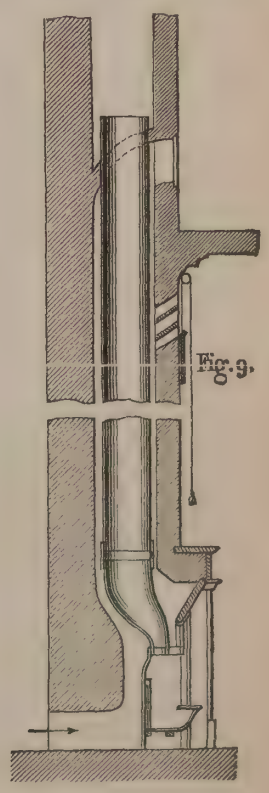
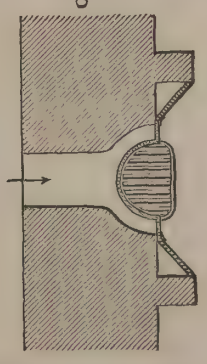


Fig. 10.



but 12 to 14 per cent., and Fondet's but 20 per cent.)

This form of fire-place is preferable to all others; it is adapted to wood, coal or coke. Table V shows the proper proportions of flues, etc.

Above the room to be warmed the warm-air shaft is discontinued, and the flue carried up in the usual way. If it be desired to warm rooms above, it may be prolonged, and registers provided above. The hearths should be as in common fire-places, of cast-iron. If coal or coke be used, the fire-place should be lined with fire-brick. A movable blower aids in kindling the fire.

The dimensions given for these ventilating fire-places cannot be much increased, even for the larger rooms. But while two ordinary fire-places in the same room often interfere with each other, two ventilating fire-places do not. Still, it is better to add proper heaters for vestibules, corriders, stairways, ante-rooms, &c., introducing into the living rooms warm air of a temperature of 94° to 100° in the upper portions.

Size of room to be warmed.	Amount of air to be changed every hour.	Sectional area of smoke-pipe.	Sectional area of shaft.	Sectional area of fresh-air flue.
Cubic feet.	*Cubic feet.*	*Square inches.*	*Square inches.*	*Square inches.*
3,532	17,658	78	39	217
4,238	21,190	93	47	260
4,297	26,487	116	58	326
6,357	31,784	140	70	391
7,770	38,848	171	85	477
9,182	45,911	202	101	564
10,595	52,974	233	116	651

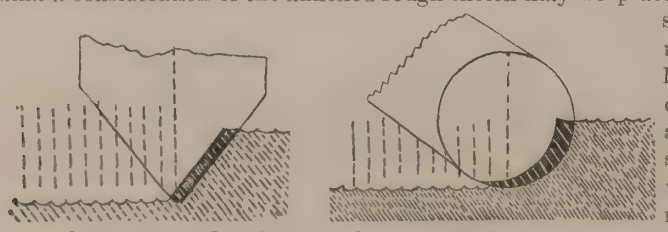
In the next article the subject of stoves, steam heating, and hot-water heating will be considered. G.

MANUFACTURING IN CONNECTICUT.

A recent tour through eleven of the manufacturing cities and towns of Connecticut, with the information derived from personal inquiries of the heads of no less than sixty-two firms, furnishes good data for a statement of the present condition and future prospects of business in the State. It gives also, to some extent, the means of judging of the condition of business throughout the country, as the products of nearly, if not quite all of the establishments, are sent all over the Union, and the correspondence of the various manufacturing concerns conveys reliable information on that subject. With scarcely an exception, the tenor of the statements made by the manufacturers is of an encouraging,or at least a hopeful character,and in most instances they are positive in the assumption that business is reviving. A partial list of the various branches of manufacture on which information was obtained, proves that the hopeful signs and encouraging facts are not confined to any one department. This list comprises the production of felt hats, locks, builders' hardware, table and pocket cutlery, plated ware, sewing machines, shirts, rubber goods, carriages, pipe fittings, steam engines, mill work, gas fixtures, kerosene goods (lamps, lanterns, brackets, pendants, etc.), cartridges, buttons, sheet metal goods, rifles, toilet pins, weighing scales, clocks, knit goods, trunk and harness trimmings, rules, try-squares, etc., machine screws, chucks, bench planes, drop forgings, steam boilers, machinists' tools, axes, etc., felts, iron from the ore, and iron castings. In some of these departments the demand is quite suggestive of the old "flush times." As an instance, the hat business—felt hats—an important industry in Fairfield county, old concerns have greatly enlarged their facilities and a number of new ones have been started; the full complement of hands is employed and the full period of hours run. In builders' and general hardware the improvement is also marked, two of the largest establishments in the State working to their full capacity. In the cutlery business the principal concerns are fairly driven to fill orders, working extra hours. The business of making steam, gas, and water fittings is also very brisk, one large manufactory reporting business as at least twenty-five per cent. better than last spring. A shirt-making concern reports double the business of last year at this time, demanding a large increase in the extent of premises and number of hands. In the production of "kerosene goods" the demand has vastly increased. One concern making drop forgings for sewing machine manufacturers, gun shops, machine shops, etc., reports a larger business during the last two months than during six months previously. A similar statement is made by a manufacturer of iron bench planes, and a firm whose machinists' tools and machines for gun-making and the manufacture of sewing machines are of almost world-wide reputation. A well-known concern employed in the production of iron from the ore of two mines and the manufacture of car wheels and axles, says that business is better than at any time since the panic. This concern runs eight furnaces, with an average production at each of three thousand tons annually, and a foundry turning out about ten thousand railway wheels per year. These are but samples of the character of the information derived from nearly all of the sixty-two manufactories from which reports were obtained. These reports are certainly encouraging. J. H. L.

SHAPE OF PLANER TOOLS.

The quality of planed work so greatly depends upon the shape of tools employed, that a consideration of the annexed rough sketch may be practically interesting. It is



singular that there is so much attention paid to lathe tools, which cut a continuous furrow around a cylinder, and so little to planer tools, which are practically making the same cut upon the unwrapped cylinder surface extended at a plane. Taking the round and the three-cornered noses for comparison, and suppose that each is given the same number of cuts to the inch—say nine. The angular tool has really for a point the arc of a very small circular or other curve. The circular nose has a larger arc, it follows that the ridge, in each cases, one-ninth of an inch wide, will be cut by the cornered tool deeper, or with sharper dividing walls, than by the round tool; the work will, as a matter of course, be rougher; about the same power is consumed in either case, the metal removed at each cut being shown in the sketch. While the engraver's second attempt to get the sections of the tool marks right, have been far from successful, and the lines, when printed, may not prove ourassertion, we believe that this is one of those things so evident that the cut may be considered only as a reminder to set men thinking, and keep in their minds the results of these thoughts. G.

LEAD-LINED JOURNAL BEARINGS.

The heating of journals is caused either by imperfect lubrication, bad fitting, or too much weight on the bearing surface. In the great majority of cases the immediate cause is imperfect fitting, irrespective of weight or lubrication, and the remedy is to be found in making the journal and bearing as nearly as possible perfect counterparts of each other in every stage of service. To make them so before they are brought into working contact is not an easy thing to do. It must be done *by* such contact, or in other words, by a speedy and effective process of self-fitting, with no excessive friction or liability to heat while the process is under way.

Every railroad is supposed to have a standard size for new journals, and every railroad man is aware that when such journals are put into service, every mile they run not only diminishes their size, but wears them more in one place than in another, causing inequality in their surfaces. Bearings with a hard, unyielding surface cannot readily be made to fit these inequalities, and consequently when new ones are placed upon worn, hollow, or badly cut journals, there is trouble, expense and delay, to say nothing of other and more serious evils. To avoid these and put an end to that prolific source of annoyance, "hot boxes," a long series of experiments were made a few years ago by Mr. D. A. Hopkins, then in the train service of the Erie Railway, with the view of producing a bearing that would *fit itself* to an inequality of size or form of journal caused by ordinary wear. These experiments resulted in what is now known as the Hopkins Lead-lined Bearing, the lead lining being merely auxiliary to the bearing proper, which is made preferably of hard bronze, and to which the thin layer or facing of lead is firmly attached by a soldering process, so that the two metals are virtually one piece. Into this lead facing the journal, under the pressure of the car, moulds or imbeds itself from the start, and afterwards gradually wears its way through it into the hard metal. The perfect fit thus secured under all conditions of the journal, aided with proper lubrication, not only prevents heating, but secures the full wear of the brasses, and makes them at all times perfect counterparts of the journal surfaces.

The relations of the brass and journal under the conditions in which the lead facing plays such an important part, are illustrated in the cuts.

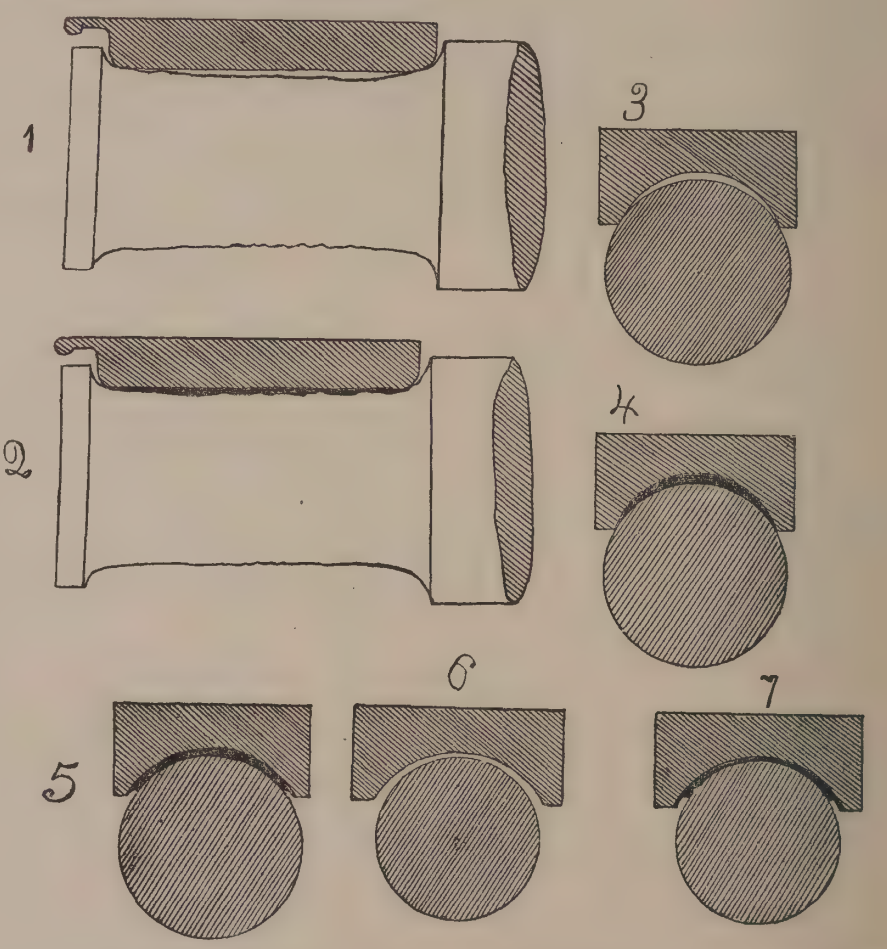


Fig. 1 shows a bearing without the lead lining, resting upon a worn and badly-cut journal, the only points of contact being near the ends. For obvious reasons, such a journal is sure to run hot.

Fig. 2 shows the application of the lead lining to the same journal, the dark shading between the journal and bearing representing the lead which has been pressed into the worn and hollow surface of the journal, forming a complete bearing and distributing the weight equally upon its surface.

Figs. 3 and 4 are sections of new, full-sized journals, with bearings that are too small, one showing the edges of the bearing only in contact with the journal in the absence of the lead lining, and the other the central space filled with lead and forming a complete bearing. The former is bound to run hot, the latter cool.

Fig. 5 is a full-sized journal with a well-fitted lead-lined bearing.

Figs. 6 and 7 represent small and worn journals with only their centres in contact with the brasses. The one without the lead will be pretty likely to run hot, while the one with the lead will, with the same lubrication, be certain to run cool, because the weight is by means of the lead distributed over a larger bearing surface.

The principle of this bearing is so plain in its application, and its advantages are so obvious, that we have perhaps taken unnecessary pains in describing it. If there are any roads in the country, however, that have not heard of it, or what is more likely to be the case, that have not tried it, we would invite their attention to the particulars set forth in this article, if they desire to be relieved of the plague of "hot boxes," which are to railroads what potato bugs and grasshoppers are to farmers, only a great deal more so.—*Nat. Car Builder*, viii, 133.

HUNGARIAN LEATHER.

Judging from the name, one might suppose that the inhabitants of Hungary were the first and the only ones engaged in the manufacture of this leather. There is no reason why it should not be called Senegal leather, as it was in Senegal and not in Hungary that the rapid process of impregnating strong hides with alum, salt and suet was discovered.

Many hundred years later it was brought to the country from whence it took its name, and afterwards introduced into France in 1573, by a tanner by the name of Bucher; but it was not until the reign of Henry IV that it attained any success, owing to the energy of Sully, then a cabinet minister.

The advantage of this leather is its cheapness, resulting from the rapid preparation and the fewer requirements. Its manufacture greatly resembles that of other leather; the hides being soaked as usnal in water, the hair shaved off—a skilled workman can shave about 12 to 15 a day.

The skins are cut in two and washed the second time for about 24 hours in the river, then placed in vats composed of alum and salt; for hides weighing from 70 to 80 lbs. the proportions are: 5 to 6 lbs. of alum and 3 to 4 of common salt, and hot water at a temperature not so high as to burn the skins. The chemical influence is the same as in the manufacture of glove leather (see REVIEW). The chloride of aluminum thus formed is preferable to alum alone. Six half skins are placed in the vat at a time.

To facilitate the chemical reaction the workman beats or tramples them under his feet; the operation is repeated several times; in this manner the skins are well impregnated; frequently they are placed in vats, for a period of 8 days, containing a weak solution of alum; they are then taken out and left to drain on planks placed in a slanting position; the liquor thus returns to the vats. They remain in repose for about eight days, then placed in the drying room where they are folded in four, more frequently in two, the hair side within, having taken especial care to stretch them well to prevent wrinkles, then piled one over the other, covered with cloths, and are left for about two days; these skins must not be too dry, otherwise it would be too difficult to work them in a satisfactory manner; they are then kneaded for the third time, to render them soft and supple.

The hides are warmed by being held over a charcoal fire; after which they are rubbed on the hair and flesh side with melted tallow, about six lbs. are absorbed by every skin. This operation is a difficult one, and great skill is required, as too much heat will make the leather brittle, if too little, the tallow is not absorbed in sufficient quantities; the same may be said of the tallow in regard to its temperature.

There are but few workmen that either have the skill or the courage to undergo the fatigue and danger resulting from the vapors of oxide of carbon. Frequent occurrence of deaths are too numerous to mention, not only in the manufacture of Hungary leather, but from other carelessness. In order to avoid accidents in the above operation, care should be taken not to enter before a current of fresh air has changed the condition of the room, and at least three hours after a meal. The first symptoms of sickness are headache, giddiness, etc.; when felt, it is of the greatest importance to leave.

The vapors from the skin of melted tallow are also very dangerous when inhaled for any length of time. In tanning establishments where precaution is taken, accidents of this description seldom if ever occur; the temperature of the room is such that the tallow will remain fluid for a long time, so that the water which the salts contain can evaporate.

The flaming operation now takes place: it consists in holding the fleshy side of the skin for about one minute over a charcoal fire, the tallow is thus compelled to enter the pores.

The skins are then piled one over another and left for about an hour; they are then rubbed on both sides to remove the excess of grease; the hides now become firm, if they are not exposed to the direct rays of the sun, as this heat will not improve the quality. The tallow now has partly combined with the hide. In France, horse hides are frequently made use of, but they would be worthless in a few hours if not immediately used after being taken from the beast. Donkey's hides are also used, but they give a very poor leather, and cannot be recommended. Hides in all of the above operations lose about ¾ of their weight; they can be kept for a long time without diminishing their qualities; it is well to have them in store some months before selling.

The skins thus prepared are converted into a leather of excellent quality for harness and saddlery work, and principally for traces for artillery; they are made of the strongest quality; five or six strips are sewed one over the other, and are covered with curried cow hide.

One of the largest establishments in the city for the manufacture of hides and tallow, was on Howard, Mascher and Putnam streets, owned by Schollenberger & Sons; this firm employed 125 hands; the value of this property was very large, but was unfortunately destroyed by fire on the 29th of September last. L. S. WARE, C. E.

ON THE DIRECT PROCESS FOR WROUGHT IRON AND STEEL.

ABSTRACT OF A PAPER READ BY CHARLES DUPUY BEFORE THE FRANKLIN INSTITUTE OCTOBER 17TH, 1877.

After very briefly explaining the difference between the "direct" and "indirect" process, Mr. Dupuy dated the beginning of improvements of the direct process, with the patent of Samuel Lucas, in 1791, which, in 1794, and for many years thereafter, were followed up by David Mushet and others. The qualty, by the direct method, being acknowledged so much superior to that made by the "indirect," that for three-quarters of a century, and to the present time, its perfection has occupied the attention of many earnest men. All the various inventions may be divided into three classes:

1. Close retorts or crucibles, being substantially Lucas' "air tight pots."

2. Tables heated above and below, supporting the ore mixture until deoxidized, and then balled on a hearth.

3. Revolving cylinders, heated outside or within, the advantage of which Dr. Siemens is now so carefully experimenting with, for the reduction of iron ores, with gas.

With this preface, Mr. Dupuy, at some length, explained the character of his process, it having the ore mixture placed within thin annular sheet iron converters, twenty inches in diameter, and three feet high, so that the charge of ore might be three charged into a reverberatory furnace, all of it could be penetrated with the furnace or four hundred pounds, and yet so arranged, that when a number of these are heat, which is not required to travel more than two to three inches, to secure a thorough deoxidization.

The indisposition to recognize the "cherry red" and the "bright cherry" red heats, as those necessary to secure perfect and commercially profitable deoxidization, is the next suggestion in the paper, and will doubtless receive due consideration by scientists.

Mr. Dupuy goes on to explain how, with thorough deoxidization, fluxes were found essential in order to protect the new metal from reoxidation from the furnace gases, as all furnace gases are more or less oxidizing. Now, said the speaker, the alkalies in quantity and kind having been determined by an analysis of the ore, they are weighed together with the carbon, and pulverized in a Chilean or Pug mill, and thence shoveled into the canisters and furnace. The carbon may be from charcoal coke or anthracite coal dust, and this last, for this region, is a highly important element for saving on waste, anthracite coal dust, and bringing it into marketble use.

He either makes iron or steel at pleasure. For iron, the ore, after it is coked down to a solid metal mass, is taken to the hammer, squeezer and rolls. After this it is cooled, piled and reheated as ordinary iron is heated. This piled or finished iron, it is claimed, makes the finest steel, when melted in pots and carbonized.

If a superior quality of iron is required, such as sheet iron, boiler plate, &c., then he takes these cakes of deoxidized metal, white hot, and, before squeezing, "sinks" them in the nobling fire, with half the labor, fuel and time required ordinarily to sink scrap in these fires.

If the ore is lean, and a more perfect separation from the metaloids' is required, then after deoxidization, he raises the heat in the furnace, and melts it down, and then balls up and hammers and squeezes, or transfers to the open hearth for steel.

Mr. Dupuy claims that these masses of white hot metals, are just the thing to transfer to the open hearth for steel rails, &c. He gives some detailed figures to show that in localities in which cheap fuel may be procured, the steel stock may be placed in the open hearth at from $17 to $18 per ton. The usual wear and tear and cost of melting, &c., in the open hearth, of course to be added.

A good deal of the paper is taken up with an interesting discussion of the causes of red shortness in this metal, and Mr. Dupuy's views threon may or may not accord with accepted theories.

One of the most interesting points, if not the *most interesting* point in this paper, is the elimination of three-quarters of the phosphorous from ores by this process.

This statement is fortified by analysis of Dr. Wuth, of Pittsburg, who stands high as an analytical chemist.

This, if true, brings in a wide range of ores, now discarded for steel purposes, and is worthy of the most careful consideration.

Mr. Dupuy speaks of the theory of the process as follows:

1. The oxygen of the ore combines with the carbon, passing off as carbon oxide. 2. The silica and alumnia combine with the alkalies introduced, and form the glazing material which covers the particles of the newly-made metals, effectually sealing these particles from reoxidation from furnace gases. 3. The phosphorus melts into this glass, and passes off with it as a slag, not contaminating the iron.

The paper closes with a comparison of the analysis of this iron, with the well known analysis of some of the best Swedish brands, and the comparison is most favorable to Mr. Dupuy's iron.

A good deal of attention is given to show the cost in detail of the manufacture of a given quantity of ore into iron and steel by this process—including cost of converter, &c.

A table is also given, showing the results of working at different places, and with different ores, with yield in blooms and much bar, from 71 to 86 per cent. of the metallic iron contained in the ore.

The paper finally closes by stating, that the operation by this process, may make the mixtures in such proportion, as to secure the exact quality of metal required at a minimum cost for carbon and fluxes.

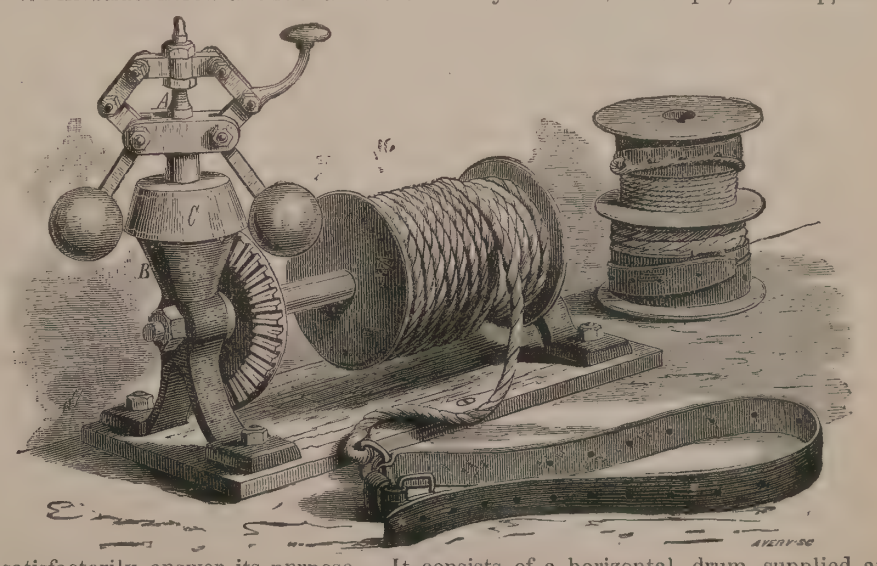
"In a word, he says, this direct process reduced the exact results of the laboratory to a large and intelligent practical working basis, for the manufacture of iron and steel, and as such, I respectfully submit it to the *impartial* and *unprejudiced* consideration of members of this Institute."

The paper throughout is clear, and its conclusions fairly deduced. We do not doubt that it will be well received and considered in that "*impartial* and *unprejudiced*" spirit which a subject so important and apparently well considered by its author is entitled to receive from all fair men, whose desire is to forward and perfect the highest attainable results in metallurgy. W.

AUTOMATIC FIRE-ESCAPE.

The terrible loss of life and destruction of property occasioned by the great fires in Chicago and St. Louis has caused inventive minds to ponder more than usually upon the necessity of life and property saving devices, and has called into existence such a number of fire-extinguishing compounds and escapes, that were they all to accomplish what their enthusiastic inventors claim for them, little need be feared from the ravages of fire in the future.

We illustrate herewith one of the most recently invented fire-escapes, which appears



to satisfactorily answer its purpose. It consists of a horizontal drum, supplied at its end with a gear-wheel which meshes in a pinion borne on the vertical shaft *A*, and thereby gives revolution to the governor balls shown in the illustration. During rotation these balls necessarily rise, and by suitable leverage depress the inverted cup *C*, which fits closely over a conical collar on the shaft *A*, and by the friction generated retards the rotation of the drum and consequently the descent of the person hanging, by means of a belt, to the rope contained on the same. The rope can be re-rolled on the drum by means of a crank, or by means of the descent of a rope wound in the opposite direction on the same drum.

CADMIUM. *

Zinc oxide is frequently found in combination with the oxides of iron and manganese; the combination, which is found abundantly in New Jersey, and elsewhere, is called Franklinite. There are several other metals, however, quite similar to zinc, which might be called its satellites, except for the fact that while they are sometimes met with in zinc ores, and not anywhere else, we often find zinc unattended by them.—There are at least three of these zincoid metals, and the existence of a fourth is suspected. These metals have been discovered in the order of their abundance: first cadmium, then indium, and quite recently gallium,—the two last having been detected by the spectroscope.

Cadmium is far from being an abundant metal, yet it is found in sufficient quantities to be used quite extensively in the arts, especially in the fine arts, both in a metallic state and in its compounds. It was discovered simultaneously by Stromeyer and Hermann in 1818, but its properties were more fully studied by the former, who is therefore usually designated as its discoverer.

Cadmium is sometimes found combined with sulphur, the mineral, which is of a yellow color, being known as *Greenockite*. This compound is, however, rather curious than useful, owing to its scarcity. It is found at the Ueberoth zinc mine, near Friedensville, Lehigh Co., Pa.; also in Scotland and Bohemia. Cadmic sulphide exists in many kinds of zinc blende; that from Shelburne, N. H., contained, according to Jackson's analysis, 3.2 per cent. of cadmium. Cadmium is also found in calamine, or native silicate of zinc, especially that from Silesia, Belgium and Spain. It is in working these ores that cadmium is obtained as a secondary product. When zinc ores are heated in contact with carbon the metal is reduced and distilled off. The vapor of zinc, on coming into the air burns, forming a white oxide (zinc white), whereas cadmium, under the same circumstances, forms a brown oxide. Cadmium, being volatile at a lower temperature than zinc, will come off first; hence, in working cadmiumiferous ores the first and brown portion of the vapors is collected apart and used to prepare metallic cadmium. The principle of the separation of zinc and cadmium resembles what is known in organic chemistry as fractional distillation, and can generally be employed to separate substances which boil at different temperatures. The vapor and smoke first given off, consist of zinc oxide together with 5 or 6 per cent. of cadmium oxide. This is mixed with one-fourth its weight of charcoal, and placed in small cylindrical cast-iron retorts, with conical receivers of sheet-iron, and then heated to redness, when the reduced metallic cadmium distils off, the heat being insufficient to drive over the zinc, with the exception of a small amount, most of which may be removed by a second distillation. To remove the last traces of zinc it would be necessary to dissolve the cadmium in hydrochloric acid, and reprecipitate it by means of metallic zinc.

Cadmium looks very much like tin, and like the latter utters a peculiar sound when bent, known as the "tin cry." This is due to the crystals grating upon each other. It is, however, harder and stronger than tin, and can be rolled into thin sheets or drawn into wire. It is nearly as heavy as copper, its specific gravity being 8.6, and it melts at from 315° to 320° *C.*, a point intermediate between that of lead and bismuth. The boiling point has been variously stated at from 720° to 860° *C.* It does not oxidize in the air at ordinary temperatures, but burns, as we have said, with a brown smoke. Like zinc, it should be melted in a covered crucible to prevent its taking fire in case the temperature becomes elevated. The total annual production of cadmium amounts to but a few tons. In 1872, Silesia produced 29½ cwt., and Belgium 6 cwt; in 1874 Prussia produced 25.29 cwt., or 1.3 tons and in 1875, 1.9 tons.

The uses of metallic cadmium are limited to the manufacture of alloys having low melting points. One of these alloys, known as "Wood's fusible metal," melts at 70° *C.*, and consists of

Cadmium	-	-	-	-	3 parts or 2 parts.
Tin	-	-	-	-	4 " " "
Bismuth	-	-	-	-	15 " " "
Lead	-	-	-	-	8 " " 1 part.

A spoon made of this alloy, when placed in boiling water, will melt like wax. By varying the proportions alloys may be obtained having any required melting points, and may be used as safety plugs on steam boilers. Wood's alloy is also used in taking impressions of objects and making moulds. An amalgam of cadmium is sometimes employed by dentists for filling teeth.

Cadmic sulphide (CdS) is made on a considerable scale for use in the fine arts, where it is known as *jaune brillant*, or cadmium yellow. This pigment is used for imparting a beautiful bright yellow color to fine toilet soaps. It is prepared by precipitating a solution of cadmic sulphate with sodic sulphide, and washing, pressing, and drying the precipitate. From its permanency as well as its beauty, cadmium sulphide would find an extensive use but for its expense; being a sulphide, it is not affected by sulphur fumes as chrome yellow is. When heated it turns brown, then carmine red, but recovers its color on cooling; it does not permit of being employed for decorating porcelain.

A pentasulphide (CdS_5) can be prepared by precipitating a neutral cadmium salt with potassic pentasulphide. It is likewise of a yellow color, and when ignited out of the air is reduced to CdS.

Cadmic bromide ($CdBr_2$) and cadmic iodide (CdI_2) have found extensive use in photography, as a means of introducing bromine and iodine into the sensitive film, being readily soluble in ether and alcohols. The former may be prepared by digesting cadmium with bromine and water; the latter, in a similar manner, from cadmium, iodine, and water. Cadmic iodide can also be obtained by evaporating a solution of 20 parts of potassic iodide, and 15 parts cadmic sulphate to dryness, extracting it with warm absolute alcohol, in which potassic sulphate is totally insoluble, and allowing the extract to crystallize.

Cadmic sulphate ($CdSO_4$) possesses some interest as the starting point from which, several other compounds, notably the sulphide, can be prepared. Its preparation is, as might be supposed, extremely simple, consisting merely in dissolving the metal in dilute sulphuric acid. When the saturated solution is allowed to evaporate spontaneously, large transparent crystals are formed, containing 18¾ per cent. of water, and having the cumbersome formula $3CdSO_4+8H_2O$. When heated to 100° *C.*, they lose part of this water, and when gently ignited, all of it; but at a stronger heat part of the acid is also expelled, leaving a basic sulphate.

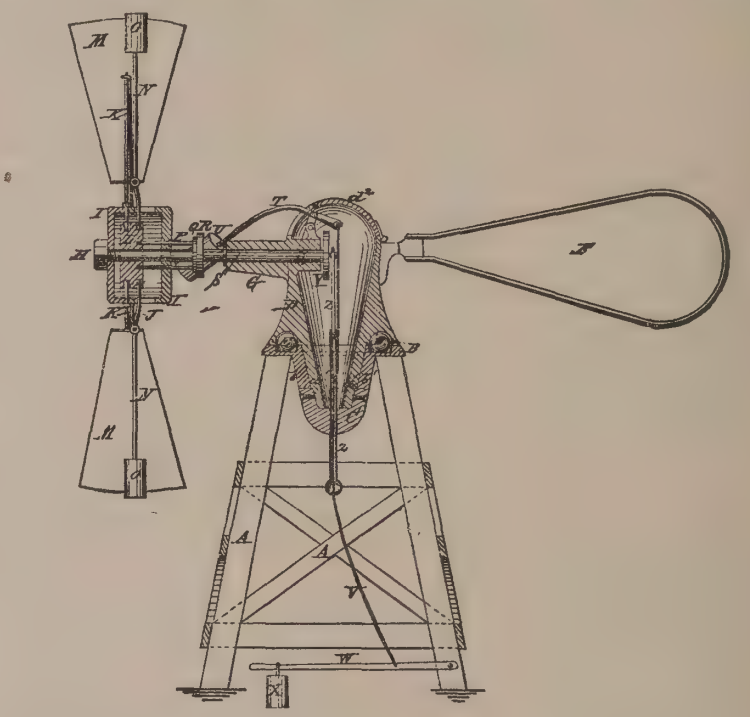
The name of cadmium is derived from *cadmia*, a word used by Pliny, and other ancient authors, to indicate the silicate and carbonate of zinc, as well as the oxide from the chimneys (*cadmia formarum*). The same word is supposed to have given us the word *calamine*, which was applied for a long time to those two ores of zinc, the term *electric calamine* being applied to the silicate to distinguish it. Recently, however, the name of *Smithsonite* has been given to the carbonate, and the confusion resulting from having two minerals with one name will soon disappear.

The chemical reactions by which cadmium can be detected are few but decisive. In acid solutions, it yields a yellow precipitate with sulphydric acid, which precipitate does not dissolve, as do the sulphides of tin and arsenic, in ammoniac sulphide. Zinc yields a white precipitate with the same re-agent only when no mineral acid is present in excess. If a strip of pure zinc be placed in a solution of some cadmic salt, the latter metal will be precipitated in metallic form upon the zinc. The separation of cadmium from copper may be accomplished by adding potassic cyanide to the solution, before passing the sulphydric acid gas, when copper is not precipitated. E. J. H.

* Boston Journal of Chemistry, xii,52 .

IMPROVEMENT IN WIND-WHEELS.*

The object of this invention is to furnish an improved wind-wheel which shall be simple in construction, strong, durable, and reliable in use, adjusting itself promptly to the wind, and running at the same speed whether the wind be strong or light.



A represents the frame or tower that supports the wheel, and to the top of which is secured the bed-plate *B*, provided with a tubular downward projection or collar *b'*. Against the lower end of the projection *b'* rests a cap or collar, *C*, which has a hole formed through it for the passage of the pitman, and which fits upon and is bolted to a tubular downward projection, *d'*, of the head block *D*, so as to keep the said head block *D* in place upon said bed-plate *B*. In the ring-face of the bed-plate *B*, is formed a ring-groove, in which roll three balls, *E*, which are pivoted in recesses in the shoulder of the head-block *D*, that rests upon the said bed-plate. The three balls *E* are arranged—two at the forward side of the head-block *D*, or toward the wheel, and one at the rear side of said head-block, or beneath the vane. *F* is the vane, which is secured to the upper part of the rear side of the head-block *D*. Upon the forward side of the head-block *D* is formed a horizontal projection or arm *G*, which is perforated longitudinally, to serve as a bearing for the shaft *H*, which is kept from longitudinal movement in said bearing by collars formed upon or attached to said shaft. To the forward end of the shaft *H* is rigidly attached a drum, *I*, to the convex side of which are rigidly attached twelve, more or less, radial arms *J*. The outer ends of the arms *J* are bent over at right angles, and to said ends are pivoted the outer ends of the rods *K*, which pass in through holes in the drum *I*, and have small cranks formed upon their inner ends, within the shell of the drum *I*. The ends of the cranks of the rods *K* enter a ring-groove in the surface of the wheel *L*, which slides loosely upon the shaft *H*. To the outer parts of the rods *K* are attached the fans or wings *M*. To the grooved wheel *L* are pivoted, at equal distances apart, the inner ends of four rods, *N*, which pass out through short slots in the drum *I*, and are pivoted to bars *n'*, the ends of which are attached to the two adjacent arms *J*.

The wheel *Q* is swiveled to another wheel, *R*, also placed upon the shaft *H*, and to which are attached the outer ends of two rods, *S*. The rods *S* pass through holes in the bearing *G*, and to their inner ends, which project into the cavity of the head-block *D*, are attached cross-pins, to receive the slotted arms of the fork of the lever *T*, which is pivoted to a stud attached to the inner end of the bearing *G*, or the head-block *D*. An arm of the lever *T*, project outer and forward, and to it is attached a weight, *U*.

By this arrangement the weight *U* tends to draw the wheel *L*, rearward, and thus turn the fans to the wind. The weight *U* also serves to hold the fans to the wind against the action of the wind, so that by regulating the position of the weight *U* upon the lever *T*, the wheel may be adjusted to run at any desired velocity.

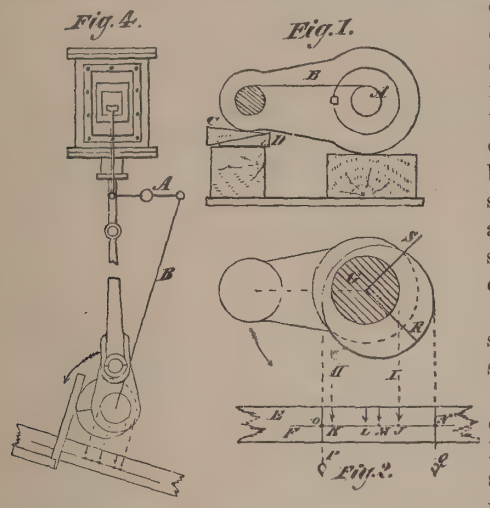
*Patented by George W. Penn, of Ottawa, and William S. Sharpneck, of Missouri Valley.

HOW TO SET A SLIDE-VALVE ECCENTRIC WITHOUT MOVING THE ENGINE.

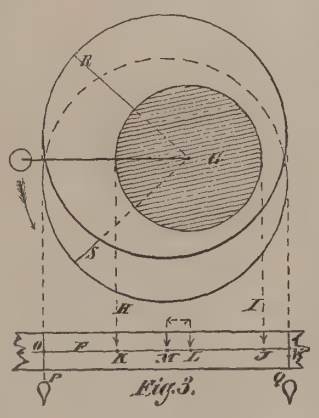
BY JOSHUA ROSE, M. E.

In setting a slide-valve for an engine whose parts are small enough to move the engine around by means of levers, the eccentric is set temporarily upon the shaft; all the valve-gear is connected, the crank is placed upon the dead centre at either end of the stroke, and the eccentric moved around upon the shaft (in the direction in which it will require to revolve) until it opens the port corresponding to the end of the cylinder at which the piston stands, to the required amount of lead. Then, if the dimensions of the valve-gear parts are correct, the eccentric is fastened upon the shaft and the job is complete. In engines having no fly-wheels, or parts too heavy to be readily moved, however, this becomes too difficult to be practical. Furthermore, it is often necessary to set the eccentric to its proper place upon the crank-shaft before the shaft goes into its place in the engine, and the following is the method by which this may be done:

For a stationary engine having a single eccentric, set the shaft in such a position that a wooden straight-edge can be placed sufficiently beneath it to be out of the way of the eccentric, place the centre-line of the length of the crank, which may be done as follows: From the centre of the crank-shaft strike a circle of the diameter of the crank-pin, as shown in Fig. 1 at *A*, and draw upon the face of the crank that shall just meet the two circles as denoted by the line *B* in Fig. 1. To draw this line place one end of a straight-edge on the crank-pin, and bring the bottom edge at the other end of the straight-edge even with the circle *A*, and draw the line; or the straight-edge, so adjusted, may be clamped to the crank-face. By means of the wedges *C D*, adjust the crank until the line *B* stands horizontally level, tested by a spirit-level or a plumb-level.



Then take a straight-edge *E* and draw on it the line *F*, in Fig. 2, and place it horizontally level beneath the crank-shaft and the eccentric, fixing it temporarily so that it will not be liable to move. To find the centre of the crank-shaft *G*, hang over it plumb lines as denoted by the lines *H I*, and where the plumb lines intersect the line *F*, mark the points *J K*, and midway between *J K* is the centre of the shaft marked on the straight-edge at *L*. From *L* mark on the line *F* the point *M* distant from *L* the amount equal to the lap of the valve added to the amount of lead the valve is required to have. From the point *M* mark on the line *F* the diameter of the eccentric producing the points *N O*, then hang over the circumference of the eccentric the plumb lines *P Q*, and when these lines coincide with the points *N O*, the eccentric is in its proper position. Here, however, it is necessary to point out that in marking the point *M* it is necessary to consider which way the engine is to run. In Fig. 2, the arrow denotes the direction of the crank revolution, hence *M* is located on the right hand side of *L*, for *M* must, in an engine in which the slide valve-gear has no rock-shaft, always be placed on the side of *L*, farthest from the crank-pin, no matter at which end of the stroke the crank stands or in which direction it is to run. But in engines having such a rock-shaft, *M* must be placed on the side of *L* nearest to the crank-pin.



In Fig. 3 is shown the operation applied to an engine, such as a locomotive having two eccentrics in order to enable it to run in either direction. In this case it is necessary to remember that the eccentric that is to operate to move the valve for the engine to run forward (that is in the direction denoted by the arrow in Fig. 3) must be the one that stands with its throw line following the crank, as shown at *R* in Fig. 3, in which the engine is supposed to have a rock-shaft, hence *M* is bearer to the crank-pin to *M*. Let us now turn to the backward eccentric, whose throw-line is denoted by *S*, its position with relation to the crank is precisely the same as eccentric *R*, save that its throw line is as much on one side of the crank as *R's* throw-line is on the other, hence the plumb lines *P Q* will intersect the points *N O* when placed on either eccentric. The eccentric that has its throw-line in advance of the crank is called the leading one, hence in Fig. 3, *S* leads. In English engines the left hand eccentric leads, while in the United States the right hand one leads. If the wrong one is made to lead, the result will be that the engine will run backwards when the reversing lever is placed to run forwards, and *vice versa*. Referring again to Fig. 2, to cause the crank to revolve the other way, all that would be necessary is to move the eccentric so that its throw-line *R* stood in the direction denoted by *S*, hence *R* in Fig. 2 and *R* in Fig. 3 represents the eccentric set to run forward, in both cases one engine having, and the other not having, a rock-shaft.

When the line of connection of the eccentric rod is not a line parallel with the centre-line of the bore of the cylinder (which it usually is), the crank must be placed on the dead centre as before, but instead of the line *F* being adjusted to the centre-line of the crank, it must be adjusted to the centre-line of the eccentric rod connection, the process being shown in Fig. 4, in which the engine is supposed to have a rock-shaft *A* connected to the slide-spindle at one end, and to the eccentric rod at the other. Hence the line of eccentric rod connection is represented by the line *B*. Instead of carrying the centre-line of the shaft down vertically to the line *F* standing horizontally, we must place the straight-edge at a right angle to *B*, and use a square, as shown in the figure, instead of the plumb lines, the rest of the operation remaining precisely as before. The operation of setting the crank on the dead-centre is the same for a vertical as for a horizontal crank-shaft, save that in the former case the line *B* must stand plumb.

[Copyright applied for.]

POWER-TRANSMITTING MECHANISM.

DRIVING POWER OF BELTS COMPARED WITH WORKING STRESS ON GEARING—II.

BY J. H. COOPER.

From John Farey's Treatise on the steam engine, London, 1827, p. 628, we extract the following particulars of Mr. Loyd's "strong cranes." "The largest size is adapted to lift twenty tons weight; the chain is made of iron, $1\frac{1}{4}$" diameter, and winds round a grooved barrel 22" diameter. The axis of this barrel is made of wrought-iron 4" square; the gudgeon at one end is 3" diameter, and $3\frac{1}{2}$" long; the neck at the other end is $4\frac{3}{4}$" diameter, $3\frac{1}{2}$" long. The barrel is turned round by this neck to wind up the chain; and the cast iron cog-wheel, which is fixed on the extreme end of the axis, beyond the neck to turn it round, is 6' diameter with 152 teeth, which are 1.49" pitch, and $3\frac{1}{4}$" broad.

"The teeth are rounded at the ends nearly to a semicircle, and the spaces between the teeth are also hollowed out nearly to a semi-circle; this form gives the teeth very great strength at the roots, where they join to the rim of the wheel. The wheel is turned by a cast iron pinion of 17 teeth, which are of a corresponding form to those of the wheel, but the pinion has a circular rim, or flange, at each end of the teeth, which greatly strengthens them, being cast in one piece with the teeth. With this form of teeth, only one pair of the teeth of the wheel and pinion are in actual contact at the same time, so that one tooth bears all the strain."

Calculation for the teeth:—

$$\frac{44800\times22}{72}=13689=\text{pressure upon the teeth.}$$

$$\text{Then}\ \frac{13689}{1.49^2\times3.25}=1898\ \text{lbs. is the proportionate pressure}$$

for cast iron teeth of 1" pitch and 1" face. This is $17\frac{1}{4}$ times our assumed standard of 110 lbs."

"These cranes are always proved by lifting the full weight that they are intended to bear. * * * They rarely break wheels, but sometimes twist, yet never break the necks of the drum shafts."

On p. 614 we find the following: "In Boulton & Watts' later engines having the sun and planet wheel arrangement in place of the crank, the teeth were proportioned nearly to the following rule:" "Teeth of 1" pitch and 1" broad, are competent to transmit a force of 176 lbs. without any risk of breaking." It is provided in this rule that the strength of the teeth shall vary as the square of the pitch and directly as the breadth.

We take pleasure in presenting the following original data contributed by Mr. J. Christie, Engineer, Pencoyd Iron Works, Philadelphia:

"In most cases of gearing the question of least pitch is an important one, not only because it contributes to smoothness of running, but also because the linear tooth bearing increases with the lessening of the pitch.

"Many of the old English rules for strength of teeth are based upon the presumption that the teeth do not in action bear over the entire length of face, but only on the corners, in which case the line of rupture is a diagonal, rendering any increase of face of tooth beyond double the length of the tooth needless. This rule may be very well for gearing on weak or long shafts, or worse still, when they overhang the bearing on weak shafts.

"To secure the advantages of face, the parts should be proportioned so as to preserve an even and continuous bearing of the teeth at all times.

"I have collected a number of cases, varying from 1" up to 4" pitch where the teeth are strained up to their utmost safe endurance, and feel convinced that the teeth of wheels can be treated in a rational way as a beam rigidly supported at one end and loaded at the other; that is loaded at the pitch line and all the load on one tooth. Further assuming that the length of beam or tooth is taken at $\frac{4}{10}$ of the pitch, a usual proportion of distance from root of tooth to pitch line, and also taking the *modulus of rupture* at 36,000, would give for the teeth of cast iron weeels, a breaking strain of 3,700 lbs. for each inch of pitch and face, and advancing directly as the pitch and the face, although the transverse strength of rectangular sections increases as the square of the depth, yet in the case of the teeth of wheels there is an inverse *decrement*, owing to the proportional increase of length of tooth.

"My rule would therefore be for cast iron teeth. *Pitch*×*face*×3,700=the ultimate breaking load in lbs. On account of the imperfect elasticity of cast iron, the working load should never exceed $\frac{1}{4}$ of the breaking strain and then under the most favorable conditions, such as well-fitted gear, rigidly supported, running at moderate speed and stress evenly distributed. For strains suddenly applied, the factor of safety should be 6, and when accompanied by severe shocks and sudden reversion of strains it should be 8. These are my conclusions, and I am prepared to sustain them by numerous examples, a few of which are given herewith: Spurwheels of $1\frac{1}{16}$" pitch and 4" face on a crane, which for years have been subject to a tooth strain of 500 lbs. per inch of face; one of 4" pitch and 12" face, every day working under a strain of 25,000 lbs. and often 30,000 suddenly applied on the teeth; another of $2\frac{1}{4}$" pitch and 8" face, subject to a frequent stress of 10,000 lbs., but which has had two breakages when the strain amounted to 13,500 lbs., suddenly applied, or 1,700 lbs. (nearly) per inch of face.

"In estimating the moment of resistance of the tooth, I use the *modulus* suggested by Rankine, viz: 18 times the weight applied at the center necessary to break a bar 1" square and 1" between supports. In ordinary foundry iron this may be accepted as averaging 36,000 lbs. as stated, but as there is a wide range in the strength of cast iron or another material may be applied, a simple experiment will determine the proper *modulus*, and according, as the result obtained will exceed or fall below 36,000, so will the proper co-efficient in the formula vary from 3,700."

IMPERVIOUS SEWERS.*

Curiously enough, the average city sewer has not only received the popular application of "drain," but, in its construction, it embodies the very principle which should be the distinguishing mark of a drain, as contrasted with a sewer. A drain is intended to receive fluids throughout the whole length, and, if possible, through its entire surface; and for this reason it is constructed either of loose stones piled in a trench, or of parallel logs similarly placed,—or of pipes having lateral or longitudinal fissures and porous walls, for the express purpose of encouraging and permitting percolation.

A sewer, on the other hand, is intended to carry off fluids more or less noxious, in order to prevent their percolation into and through the soil. For this reason it should possess no fissures or pores which would permit percolation; and all inlets should be so trapped as to prevent any of its contents from obtaining exit, except in regular course of discharge.

An impervious drain and a pervious sewer are equally absurdities; but the latter is more than absurd, it is expensive and inoperative, and even worse—it is directly harmful.

We may state, as the general principles underlying sewer-building, that each day's influx should be promptly passed out by natural flow or by flushing, and not allowed to deposit sediment, and gradually clog up the line, or to putrify, ferment and breed disease. There must be considerable descent or incline—less than 1 in 440 will require flushing.

The alignment should be good, especially that of the bottom. The descent should be uniform; the interior surface smooth, so as to reduce friction and not to cause or favor clogging, the walls should be absolutely impervious, and the section such as will cause the most rapid possible, flow with a minimum of sewage.

To aid in the alignment, the sewer should not be constructed directly upon shifting soil; but a concrete or other foundation should be provided, to prevent vertical bending of the sewer line, and the consequent formation of hollows to catch the sewage.

Rapid flow being a desideratum, smooth interior walls should be provided. Mortar projecting from the joints of a brick sewer, markedly impedes the flow and arrests the putrefiable material.

Apropos of bricks, the employment of this material necessitates a much larger pipe than if the walls were smooth and in line; not only because of the natural roughness of the bricks and of the projecting mortar, but because pockets are formed by sinking of the individual bricks, or traps made by their projecting beyond the regular wall surface.

A flat-bottomed sewer is the worst form, as regards the velocity of flow which it permits; a circular bottom is better; an egg-shaped section, with the point downward, permits of a minimum current flushing and cleansing the bottom.

It would appear to be obvious from the foregoing remarks, that a sewer constructed of brick-work, no matter how well put together, will not be able to realize in practice, save for a very limited period, the requirements which an intelligent knowledge of the sanitary elements involved in the removal of sewage show to be necessary. No brick-work can be made to remain impervious under such conditions.

The mortar constantly moist, must sooner or later succumb to the disintegrating action of the materials passed through it, and the whole line gradually passes into the condition of a sieve, allowing the liquid portions of the sewage to pass through it and to saturate the sub-soil and retaining the solid matter. Thus are several evils called into existence.

First, the saturation of the soil about the line gives rise to contagious fevers, and the capacity of the sewer is gradually diminished by the accumulation of solid refuse, thus intensifying the first evil. In no other way can these difficulties be obviated, than by entirely dispensing with brick sewers, and by constructing these important structures of vitrified clay or some analogous materials. The improvements that have been made in the manufacture of this class of materials, have been such as to quite meet every objection to their use for this purpose, both as to durability and cost.

The introduction of a method of glazing these pipes, known to the trade as "slip" glazing, has enabled the production of an indurate siliceous surface, which will resist the severest chemical action that can be conceived to exist in sewage waters, even under the most unusual circumstances, as where the pipes receive the waste waters of chemical manufactories, dye works, &c., while their imperviousness by permitting the draining off of the sewage waters avoids the evils of the packing of the solid refuse, and the clogging of the line; thus permitting of the use of sewer pipes of clay of much smaller diameter to do the work demanded of them, than would be possible with bricks, and assuring the work to be done properly without contamination of the surface soil, and the train of evils that result therefrom.

The "slip" glazing, to which we referred in the foregoing, as a notable improvement in the manufacture of vitrified clay pipes, is produced by dipping the unburnt piece into a mixture of so-called "slip clay," or Albany earth and water, which, under a white heat continued from twelve to thirty hours, produces a vitrified and very durable siliceous surface upon the wares. The general practice in this country, heretofore, has been to employ what is called "salt glazing," which process is effected by throwing common salt into the kiln at a proper heat, which produces from the nature of the operation, a very thin, glazed surface; inasmuch as the action of the salt vapors can only affect the material of the pipe to a very limited depth. It is questionable, too, whether this surface, aside from its want of density, can withstand chemical agents, alkaline or acid as well as a silicate glaze, containing notable quantitities of lime in its composition, which the glaze produced with the "slip" possesses.

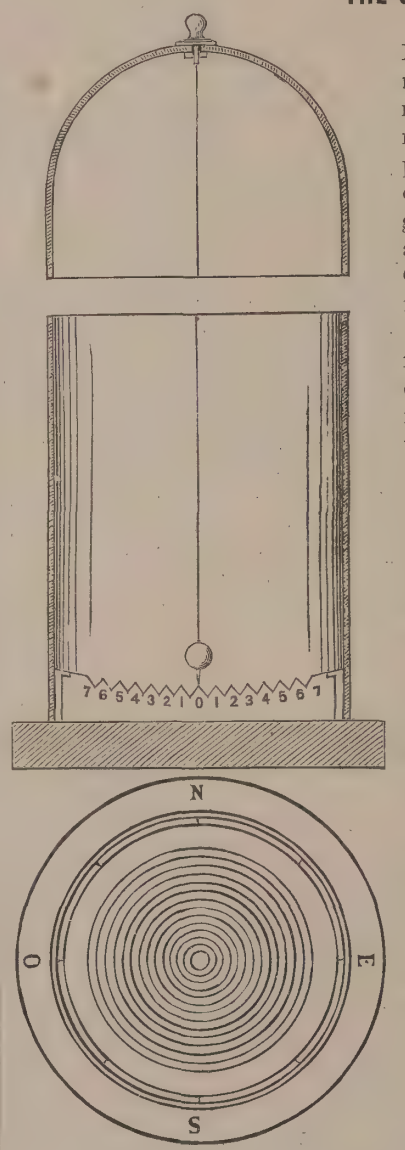
An examination of the character of the surfaces of slip and salt glazed wares, will not fail to convince the observer of the superiority of the former as compared with the latter, as to its ability to resist chemical action. The clay used in the production of the slip glaze is at present found in one locality only, near Albany, N. Y., and in appearance it resembles an ordinary potter's clay. A chemical examination, however, shows it to contain an appreciable quantity of carbonate of lime and alkalies, to the presence of which its efficiency in glazing must be ascribed, since at the high heat of the kiln there will be produced, by the action of these alkaline ingredients, a decomposition resulting in the formation of a vitreous double silicate of the lime and alkalies with the alumnia of the clay. The glazing which is produced in this manner is denser, and has far better resisting qualities to either acids or alkalies, than can possibly be expected of the surface produced by salt, and has been demonstrated by actual experiment to withstand unaltered the action of concentrated sulphuric acid for the space of four years, while salt glazed ware, subjected to the same test, was rapidly destroyed, as might have been anticipated from the manner of its production.

We understand that, at the present time, an active discussion is going on in Philadelphia, between the city authorities and the advocates of vitrified clay pipes, as to which class of pipes (salt or slip glazed wares) to adopt in place of the present wretched brick sewers, than which nothing could be more abominable. This question, which is of such sanitary and financial moment, must be decided in favor of the slip glazed ware, if general principles, backed by positive experiment, can be relied on to form a judgment. We should be pleased to see the experiment tried of adopting impermeable for permeable sewers, feeling assured that the result will abundantly verify the expectations that their advocates claim for them.

The chemical nature of liquid refuse (and the gases evolved from it,) which are passed through city sewers, is not always uniform. Where the material is exclusively animal excreta and kitchen refuse, it will be strongly alkaline; but where the refuse of chemical manufactories, dye and print works are emptied into the line, the liquid contents may be strongly acid. In either case, the action of the liquid upon the mortar of brick sewers is certain to disintegrate it rapidly, and transform the line gradually from the condition of a sewer into that of a drain or sieve. Under any circumstances, impervious sewers are the best and should be universally adopted, even should their first cost be greater than those of bricks. The advocates of vitrified clay pipes claim that a glazed clay pipe of 48 in. diameter will do the work of a 12 ft. (?) sewer of bricks, at about three-fourths the cost of the latter, and with enormously increased powers of endurance. W.

*We are credibly informed that the present brick sewers in Philadelphia, at least those four feet and under' are mostly constructed of loose bricks of the worst quality, and very little morter or cement, so that it need excite no surprise that as regularly as a rain storm occurs the morning newspapers contain accounts of "broken sewers." The annual cost to the city of Philadelphia to repair and clear brick sewers is certainly not far from $100,000; an amount which would build 50,000 feet of new sewers, which will never need either repair or cleaning.

THE SEISMOMETER.



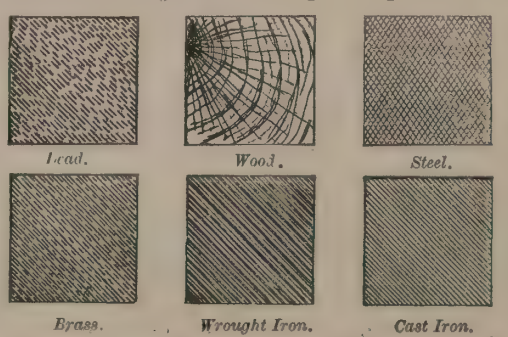
This apparatus, which is the invention of Dr. Miguel A. da Silva, professor of geology and mineralogy at the Polytechnic School, Rio de Janerio, was invented to determine exactly the measure of the volcanic forces. It consists of a pendulum, the cord of which, metallic, destitute of torsion, is fixed at the top of a cupola *a*, or a glass bell in a smaller model, by a mechanical artifice analogous to that which was adopted by Coulomb in his balance destined to measure magnetic and electric forces.

The bell is placed on a horizontal platform of marble or metal, which must be closely connected with the earth, and placed in a situation remote from streets or factories, to avoid the shock transmitted to the earth by the rolling of carts or wagons, or by the shaking of machinery. On the base of the cupola, around the center a point above which the pendulum hangs when at rest, the inventor disposes in a series of concentric circles or monticules, (formed of a pulverulent substance, of metallic nature), the size of which increases gradually from the center toward the periphery, so that the superficies which passes through their crests shall be spherical in form, of a radius a little less than that of the pendulum hung from the bell top, so that the vibrations of the pendulum produce tracings in the summits of the concentric ridges. As these ridges are numbered from the center toward the periphery, and are in a definite scale, the intensity and order, as well as the direction of the forces producing the vibrations, can readily be read off. The cardinal points of the compass are marked around the base, which should be comformably placed.

The cuts (for which as well as the description we are indebted to the *Aurora Brazileira*) show the device in longitudinal vertical and in transverse horizontal section, and need no further explanation. G.

SECTIONAL SHADING.

It would be very desirable if there were absolute uniformity of usage in respect to sectional shading or "hatching" to represent the various materials used in construction.



Such usage is now near enough to uniformity to make it very annoying and misleading in certain cases; and we try to submit here for general approval and use a series of sections, prepared by no less authority than Prof. Cawthorne Unwin.

In heralding, the various colors are indicated in engravings, sketches, &c., by horizontal, perpendicular, and vertical lines, varied with dots, &c. The usage is absolutely uniform among all nations, and we would be glad to see section-hatching given the same universal recognizability. G.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS, AND TECHNOLOGY.

Reagent for Glucose.—Probably the most delicate test for the presence of glucose, particularly in urine, is that proposed by Boettger, namely, to boil the urine, previously mixed with solution of sodium carbonate (1 part cryst. sod. carb. to 3 pts. water), with a very small quantity of bismuth subnitrate for some time, and then to allow the liquid to deposit. If glucose is present, the sediment exhibits a gray to deep-black color, according to the quantity of grape-sugar present. To obtain reliable results, however, it is necessary that the urine be absolutely free from every trace of albumen, or other protein-bodies, because the sulphur of the latter would produce black bismuth sulphide, which might be mistaken for the grape-sugar reaction. There are several well-known methods for removing such protein-bodies; but O. Maschke has lately proposed a new one, which appears to accomplish the object with absolute certainty. He precipitates the albumen, etc., with a solution of sodium tungstate strongly acidified with acetic acid. A sample of the urine is mixed with $\frac{1}{4}$ to $\frac{1}{3}$ volume of the sodium tungstate solution, and the liquid is filtered after a few minutes (if a precipitate was produced). In case of an abundant precipitate, the filtrate must be tested with a new portion of the reagent, to make sure that the precipitation was complete. The clear filtrate, freed from albumen, etc., is then mixed with half its volume of solution of soda (or an equal volume of solution of sodium carbonate), and a small quantity of bismuth subnitrate—about as much as half a pepperseed—is added. Without regard to any violet, blue or green coloration, which is often produced immediately, the mixture is first well shaken, and the bismuth is allowed to settle. If the latter has assumed a gray, brown, or black color, the urine contains alkaline sulphides, (Na_2S) which must be removed. In this case a new portion of urine is slightly acidified with acetic acid, and briskly shaken up with a small quantity of bismuth subnitrate. It is then filtered, and afterwards, if necessary, freed from the albumen by the above process.

To bring about the reaction with glucose, the mixture of urine, soda solution and bismuth subnitrate, must now be boiled. In presence of much glucose an immediate browning of the mixture will be observed, and the boiling may soon be interrupted. Traces of glucose, however, can only be detected by protracted boiling. The reduced black bismuth is generally deposited last, so as to form a layer over any remaining undecomposed bismuth oxide. This reaction is capable of showing the presence of as small a quantity as $\frac{1}{100}$ per cent. of glucose in urine; and since glucose appears to be a normal constituent of urine, although only present in traces, it might become a question of doubt, whether a particular kind of urine is diabetic or not. It may, however, be safely assumed, that no urine should be considered diabetic (specific gravity and quantity being normal), unless abundant reduction of the bismuth salt takes place before the actual boiling of the test-liquid mixed with the urine.—*Zeitsch. f. Anal. Chem.*, 1877, 425.—*New Remedies*, vi, 332.

Thymol. — This substance, which is homologous to phenol, and is sometimes called thymecamphor or thymic acid, has the composition $C_{10}H_{14}O$, is found in the ethereal oils of *Thymus vulgaris* L., *Monardo punctata* L., and *Ptychotis Ajowan* DC. It may be obtained by shaking the oil with soda, and decomposing the sodium compound with dilute hydrochloric acid. It has strong antiseptic properties, almost as strong as phenol, and has the advantage of not being caustic, and possessing an agreeable odor.—*New Remedies*, vi, 349.

Iron Articles to be Bronzed, are, according to a process by M. P. Hess, heated in the air after being coated with linseed oil. Objects which cannot be exposed to high temperature may be steeped in a slightly acid solution of ferric chloride, plunged in hot water, and when dry rubbed with linseed oil or with wax. To preserve iron from rust the author recommends sulphide of copper. He steeps the iron for a few minutes in a solution of sulphate of copper, and then transfers it into a solution of hyposulphite of soda acidulated with hydrochloric acid. The result is a blue black coating, not affected by air or water.—*The Engineer*, ixlvi, 315.

Conductivity of Flames.—Herr Edmund Hoppe, by investigating the electric conductivity of flames, finds that in any particular kind of flame the conductivity increases with the temperature and with the quantity of burning gas. With different kinds of flame the conductivity depends on the nature of the burning substance; salts of potash, soda, barium, strontium, lithium, thallium, and especially copper increase the conductivity of the hydrogen flame. He also finds that Ohm's law applies to flames.—*Telegraphic Journal*, v, 266.

Manufacture of Brick from Granulated Slag.—Attempts to utilize the cinders from blast furnaces have for many years occupied metallurgists, both in Europe and America, but it is only within the last few years that they have been successful. At Georg-Marien Huette, near Osnabrueck, efforts in that direction date as far back as 1859, efforts which, persistently renewed, have finally led to success.

The cinder, granulated by allowing it to flow into water, is used instead of sand in making mortar, for which it possesses the great advantage that much less lime is necessary in order to obtain mortar of standard excellence. By granulating a portion of the silica in the cinder is rendered easily soluble, and, owing to its presence, ordinary granulated cinder, when stored for a while, will be cemented together by the hardening of the silica. This property aids rapid hardening, which, with ordinary mortar, is due to the slow formation of carbonate of lime; while the formation of silicates is but slight and is effected only in the course of years.

The hardening of a mixture of granulated cinder and of lime which is used for making brick is effected;

1. By the formation of a chemical combination with a soluble silica present in the granulated cinder.

2. By the formation of a chemical combination of that part of the silica which, though it is not soluble, will nevertheless enter into compounds readily.

3. By the formation of carbonate of lime, as in ordinary m

The bricks made preserve their shape well because they are not burnt. Trials made at the Royal Polytechnic Academy at Berlin to ascertain the resistance of the brick to pressure, proved it to be superior to masonry built with ordinary mortar, and almost equal to red brick laid in cement.

An advantage of the granulated cinder brick is its porosity, the value of which property for the materials of dwellings, Von Pettenkofer has so eloquently pointed out in his lectures on the hygiene of the house.

The production of the Georg-Marien Huette up to the close of 1876 amounted to 39,000,000 bricks.—*Metall. Rev.*, 1, 394.

Influence of Heat Upon Magnetization.—M. Fave pointed out that when a bar of steel is magnetized at about 360°, allowed to cool, and heated again, the quantity of magnetism augments, and may reach the triple value which it had preserved after cooling. M. Wiedemann maintains that a bar magnetized at an elevated temperature loses, on cooling, a part of its magnetism; it loses a further portion when heated again, but on cooling it resumes a part of what it had lost. M. Gaugaiu believes that this contradiction is due to the circumstance that M. Wiedemann experimented only with bars heated to 100°, while M. Fave operated with bars magnetized at a far higher temperature.—*Chemical News.*

Imitation of Marble.—Accordng to Herr Karl Boschan, casks of gypsum or *papiermache* can be prepared to closely imitate marble, by the application first, of a coating of thick Damar varnish, giving the appearance of alabaster, and upon this, when dry, a second coating on which crystallized gypsum is sprinkled, not too finely ground. This procedure is an imitation of nature, for alabaster is composed of very fine crystals of sulphate of calcium, and Carrara marble of somewhat larger crystals of carbonate of lime, which reflects light and glitter similar to crystallized sugar; the same effect is produced by the crystals of gypsum.—*Bay. Ind. & Gewerbe Blatt*, ix, 291.

The Bronzing of Cast Iron can be accomplished, according to Dr. C. I. Durre, by coating the surface of the iron (cleansed by means of acid and well etched) with ferrocyanide of copper, applied with linseed oil. Before this coating is entirely dry, the bronze powder is applied by means of a fine brush, and then well polished by means of a burnisher. After the surface is entirely dry, it is well washed and etched to the color desired. The use of the alkaline sulphides for the etching produces olive green and black colors, which closely resemble those on the Japanese bronzes.—*Maschinenbauer per Bay. Ind. & Gew Blatt*, ix 291.

Austrian Ordnance.—It transpired recently at Vienna, that some of the officials of the arsenal had betrayed the secret of the new Austrian steel bronze cannon to the Prussians and the Italians. The traitors now stand before a court of justice. The secret which has been divulged appears, however, to have never been a very profound one; the so-called steel bronze is nothing but hard bronze obtained by a process which is a combination of three different systems. The first is Rodman's, viz., the hollow casting effected by cold water in the center; the second is Whitworth's system of casting under pressure; the third is an addition of phosphorus to the alloy.—*Engineering.*

*"Ueber die Herstellung der Mauersteine aus granulierten Hohofenscklacken": Luermann, Witting & Meyer, Osnabrueck, 1877.

Artificial Ivory.—M. A. Gawalowski (in the *Bay. Ind. & Gewerbe Blatt*, ix, 290) describes a new substitute for ivory which is said to be not only 30 per cent. cheaper but in some respects even superior to ivory proper. The substance is susceptible of a very high polish, is of great hardness, and has a specific gravity of 2.09 (that of ivory being from 18.7 to 1.89). If the mass be placed in water it swells to a spongy consistency, loses its color, and becomes pasty. The powdered material is easily kneaded with water to a doughy consistency, and on an exposure of from 4 to 6 days in the atmosphere regains its original hardness. The material is claimed to be well adapted for the manufacture of billiard balls, handles for canes, cutlery etc. An analysis of a red product showed the compound to be composed of

Water,	8.80 per cent.
Peroxide of lead,	16.04 "
Sulphate of baryta,	26.05 "
Silicic acid,	5.86 "
Silicate of alumina,	4.84 "
Ferric oxide,	1.55 "
Gluten,	34.21 "
Lime,	3.91 "
Traces of Fuchsin,	
	101.26 per cent,

Other specimens appear to be formed by the admixture of heavy spar, clay and lime, rosanilin as the coloring material. The utility of this compound is much impaired by the action which moisture has upon it, and its unfitness for the manufacture of toys and like products as are apt to be placed in the mouth by children is evident from the percentage of lead contained.

The Widening of Spectra can be accomplished, according to Kohlrausch, by the employment of cylindrical mirrors whose axes are placed parallel to that of the dispersing prism. The importance of the substitution of mirrors for the costly prisms is manifest, for where a wide spectrum is desired many of the latter would be necessary to accomplish what comparatively few of the former would, according to Kohlrausch, accomplish equally well.—*Poggendorffs Ann.*, xvi, 464.

Influence of Pressure on Combustion.—M. V. Wartha has been making experiments on the influence of pressure upon the phenomena of combustion. He has burnt stearine candles in the air at an ordinary pressure, and at a pressure of 1.95 atmospheres in a large iron chest, determining in each case the quantity of matter burnt per hour. Those burning at the common pressure had a flame 4.5 to 6 centimetres in height, and consumed hourly from 9.34 to 10.80 grammes of stearic acid. At the increased pressure the flame was very sooty, of a yellowish red, and from 9 to 12 centimetres in height, but the quantity of stearic acid consumed was only 7.99 to 9.11 grammes. He burnt also candles at very low pressures, as. *e. g.*, 9 centimetres of mercury. The flame was much increased, lost its brightness, and took a greenish-blue color. Three portions could be plainly distinguished—the central part of a greenish-blue, quite detached from the wick, and having the form of a cap. This part is enveloped in a violet mantle, and this again in a second violet mantle, so pale as to be scarcely visible.—*The Engineer.*

Transparency of Iron Heated to Redness.—It has been affirmed by P. Secchi, of Rome, that iron heated red is transparent to light. This is denied by M. Govi, of Turin, who, in a paper to the French Academy, describes some experiments on the subject, and shows how one may be deceived in studying the phenomena. If a mixture of borax and carbonate of soda be fused in a thin platinum crucible raised to a red heat, there will be seen on the exterior of the vessel the form of the liquid mass with all its accidents of rapidly varying form, indicated by a zone of less brightness than the upper portion of the metallic surface. At first sight it is natural to infer a transparence for light of the heated platinum, but (M. Govi points out) the case is really one of transparency for radiant heat; that is to say, a phenomenon connected with the good conductivity of platinum. The liquid, liberating carbonic acid, is less hot than the crucible, and is constantly borrowing heat from it. It is inevitable, then, that at every point where the liquid touches the metal, the latter relatively cooled, should appear less luminous than in the neighboring region. M. Govi gives some other examples of the phenomenon.—*Nature*, xvii, 17.

The Removal of Tin from Copper Vessels coated therewith, can be easily accomplished, according to Professor Bottger, by immersing the vessel in a concentrated solution of sesqui-chloride of lime. In a very few moments the tin is removed from the copper, and nothing remains to be done but scour the latter with moistened sand and dilute hydrochloric acid to obtain a perfectly clean surface.

ENGINEERING—CIVIL AND MECHANICAL, &c.

Sewer Ventilation.—It is very well known that if the air in sewers could be kept in continual motion in one direction, so that no stagnation could take place, the danger attending the development of sewer gases would be avoided. To this end vertical shafts have been proposed, and tried without success, for causing the upward current of the sewer gas or air. Similar shafts are now proposed by Mr. R. Parker, surveyor to the Board of Works for the Poplar district, but in place of using them as uptakes, he provides their upper ends with a cowl, the opening of which is always presented to the wind which enters the sewers, and keeps up a current that constantly changes the gaseous contents of the sewer by driving them out at every opening. Mr. Parker proposes to use a number of cast iron shafts, erected about 12 ft. high and 10 in. diameter, in convenient and open places, and also pipes of various sizes according to circumstances, from the sewers and existing drains at the rear of houses, to the house top as high as the chimney stack, and these pipes or ventilating shafts should be surmounted by a cowl, guided by a vane attached to it, so that its opening or aperture shall always be facing the wind. The air or wind impinging upon it will force down the air within it, and pass into the sewer and travel along it, entering all drains and ramifications to find an outlet so that it may escape. The air within the sewer requires very little force to cause it to move forward, as it has in itself a tendency to move upwards. He has made some experiments which are described in a recent report to the Poplar Board, "to see if the force of the wind and air could be conducted into the sewers, in this way to force out the gases and keep up a constant current of fresh air; it has been found that there was always a downward current in the ventilating shaft, and an upward rush of pure air in all the gulleys and drains in its immediate neighborhood." A shaft was constructed from a drain to the roof of a house in Bow, the distance from a cowl to the sewer being 13 ft The average results of the first seven experiments gave:—Temperature outside sewer, 43.28 deg; temperature inside sewer, 48,86 deg; velocity of wind outside sewer, 4.61 miles per hour; velocity of wind at junction of 9 in. drain in sewer, 1.81 miles per hour. Cubic feet of air forced into sewer per hour, 4,210.—*The Engineer.* lxlv, 315.

The Second Steam Street Motor, built at the Baldwin Locomotive Works, for the Hill and West Dubuque Street Railway Company (Dubuque, Iowa), was placed on that road recently. The new motor, "Excelsior," is somewhat larger than the "Pioneer," and is supplied with additional safeguards against accidents. It has the Chatalier brake, steam knuckle-joint brake, and safety brake or emergency shoe, an appliance that precludes the possibility of the motor running away on the down grade. The motor is also supplied with injectors, force or plunge pumps, apparatus to heat the water, and one to warm the car by steam. The tank has a capacity of 274 gallons. In a recent article in the *Railway World* mention was made of the difficulties which had to be surmounted in order to build Dubuque's street railway from the business to the residence portion of the city, on the bluffs, 350 feet above the Mississippi. The construction of a smokeless and noiseless engine to run through crowded streets and reach an altitude of 350 feet in less than one mile, is a triumph of mechanical engineering deserving of recognition. The Baldwin steam street motors have solved the troublesome problem of rapid transit in great cities.—*Railway World*, iii, 1117.

Extraordinary Wire Rolling in Warrington.—The Pearson and Knowles Coal and Iron Company have of late turned special attention to the rolling of exceptionally long lengths of wire rods for fencing and other purposes, and with this object have adopted Mr. J. J. Bleckly's patent four-high wire mill, the results obtained from which, both in length of rods and amount of work turned out, are, we believe, quite without precedent. Last week, in two shifts of ten hours each, the extraordinary quantity of 40 tons 9 cwt. 2 qrs. of No. 4 finished puddled wire rods were rolled in this mill, the individual rods ranging in weight from 45 lb. to 70 lb. each; and the average production of the mill during the whole week was 18 tons 2 cwt. 2 qrs. of No. 4 iron, per shift of ten hours. One distinguishing advantage obtained in this mill is that in consequence of the arrangement of the rolls, only one-half the number of men usually employed in a wire mill is required.—*Warrington Guardian.*

MINING, METALLURGY AND MINERALOGY.

A Remarkable Accident happened at the North Ashland Colliery, near Ashland, Pa., on Nov. 21st.

The coal is hoisted from a slope in the Mammoth Vein, lowered on the surface by means of a self-acting plane to a railroad, and conveyed by a small locomotive to the breaker about three-quarters of a mile away. This road is laid on a heavy descending grade, and the wagon wheels during the trip are always "spragged," or blocked with a double pointed billet of wood about eighteen inches long.

On this occasion, however, the sprag-man neglected his duty; and, becoming sensible of the increasing velocity thus occasioned, the engineer fully reversed his engine. But the heavy burden pressing on with growing rapidity, soon became unmanageable. It was impossible to stop it, for they had no sprags on the cars; so the engineer tied his whistle open to sound the warning, and waited for his last chance. On they dashed, faster still and yet faster, till nearing the breaker, the engine struck a short ascending grade. Here the men leaped out and, catching some sprags from the spot where they are laid, they succeeded in getting three between the spokes of the wheels. But the hindrance was insufficient and too late. The cars ran on at full speed, with the whistle shrieking its loudest blast. Approaching the breaker one of the tip men just had time to elude it, as it went careering at its headlong pace, clear over the tip and down about thirty feet of dump shute. In its descend the front wagon, heavily loaded with rock, struck upon the rear bumper of the locomotive, throwing the front upwards with tremendous force through the roof. Fixed in this immovable position the locomotive blocked the otherwise open way through the lump coal shute down to the lower railroad, about seventy feet vertical distance. The whistle being open prevented the explosion imminent; but the sparks ejected, lit the shingles of the roof, rendered still more inflammable by the almost impalpable covering of coal dust, which covers such buildings. In an instant there was a blaze. At once attacked, the flames were subdued after a hard struggle, and the fire was likewise drawn from the locomotive.

Seven hours after the accident the cars and locomotive had been hauled out of the shute by means of chain, blocks and and tackle, and the breaker was again in working order. No one was hurt; and the only injury of consequence was sustained by the breaker in the splitting of a couple of timbers by the shock.

Paraff and the Philosopher's Stone in Chili.—The folly of fools is beyond comprehension, and the credulity of avarice without limit. This may not be one of Solomon's proverbs, but it is for all practical purposes just as good as though it were. Witness the following paragraph concerning the wonderful doings of Mr. Paraff in the transmutation of metals. Mr. P. must be a clever conjurer, for he seems to have carried the Chilian capital by storm, and is certainly "making money," whether he is converting one metal into another or not. We are told that the people are so desirous of getting his precious stock, that he cannot supply them as fast as they desire it. We hope it is scarcely necessary to say that there is deception somewhere. At this distance we do not pretend to say where, and possibly the credulous investors may never find out where, any more than they will find the whereabouts of their vanished pesetas; nevertheless the final result is as certain as when the alchemists of old deceived the fools, sometimes including themselves, of their day.

The following is clipped from the San Francisco *Bulletin:*

"A gentleman residing in this city, who is in close correspondence with relatives in Santiago, the capital of the Republic of Chili, states that Paraff has maintained himself, despite the opposition brought against him. He has now three establishments in operation, and is producing wonderful results. He has organized a company with a capital of $8,000,000, and the people are absolutely crazy to procure stock. Copper mines that were formerly comparatively valueless are now held at exorbitant figures, and prospecting is active in every direction. One of the instances of Paraff's assays is interesting. A ton of copper ore from the Caracoles district was submitted to several of the well-known assayers in the presence of a number of citizens, Paraff also being present. The assayers announceed the result—they had obtained 4½ per cent. of gold. Thereupon Paraff suggested that there must be more of the precious metal in the ore, but the assayers were prevented finding it on account of its being hidden by the copper. He produced the chemical powder, which he calls 'reactive,' and this was submitted to those present, and in its turn analyzed, without detecting the presence of gold. Scattering this over the pulverized mass, and allowing about half an hour for manipulation in order to produce thorough incorporation with it, he asked the metallurgists to reassay the ore, when the astonishing result of 37½ per cent. was reached. Paraff is reported to be on the top wave of success. He has purchased the Quinta, on the Canada, the principal street of Santiago, the former residence of the late Harry Meiggs, and which cost him $500,000, and there receives the worshippers of the golden calf in right royal style. Chili is beginning to believe in him as its financial savior, and his influence is only limited by the credulity of the people."

P. S.—Sooner than we expected, when the above was "set up," comes the *denouement*, as follows:

"Paraff, a gold swindler of Chili, and his accomplices are in prison, pending the result of the criminal suit which has been commenced in Valparaiso. It is said that a case of the copper from which Paraff used to pretend to extract gold by his process of beneficiation, has been sent to the court by order of the judge, who desires to satisfy himself as to the genuineness of the invention by seeing the author of it produce in his presence, and in the presence of others to be appointed for the purpose, the results which have so thoroughly tested the gullibility of the public."—*The Engineering and Mining Journal*, xxiv, 396

MISCELLANEOUS.

American Ship-Building Reviving.—Comparatively few people know to what extent ship-building has increased in the United States within three years. The idea, apparently, has prevailed that England was far outstripping this country in this industry. A visit to Chester, Pa., and an inspection of the ship-building yards of John Roach & Son, show the advance made in this country. This establishment is not confined to Chester alone, but also includes what were once known as the Morgan Iron Works, at the foot of Ninth street, East River, in New York, and, it is asserted, has the most facilities for the work of any yard in the world, not excepting that of John Elder & Co., on the Clyde. During the past year, ten new iron steamships, representing 24,000 tons, have been built at Chester. Mr. Roach is probably one of the most energetic men engaged in steamship building in this country, and to see him about his shops one would take him to be one of the workmen. In dress he is eccentric, as he is also in other things. He is a welcome customer to opticians. He buys eye-glasses by the dozen, and from every pocket of his clothing he can produce pieces of glass, springs or rims.

Mr. Roach, a few days ago, in speaking to a reporter of *The Tribune* about the impression that this country was being superseded by Europe in shipping interests, said: "The continued cry that there is a growing decrease of American tonnage is a mistake. There is actually an increase. During the war a great revolution in the construction of merchant ships all over the world took place. Steam superseded sails, iron ships were substituted for wooden ones, screw steamers displaced those with side-wheels, and the compound engine took the place of the simple type. While the war continued, advantage could not be taken of these improvements, and England availed herself of the opportunity. At the close of the war the condition of American shipping was discouraging. There was not a ship-yard in the country in which a first-class iron ship could be constructed. A large number of side-wheel steamers were thrown on the market, and subsidized lines were established to run to this or that foreign port. These steamers have become obsolete, and others must take their place. Iron ships can be produced in this country at a cost within ten per cent. of what they can be furnished for in Europe, and from the superiority of the workmen, material, etc., they can be better constructed. English shipbuilders already acknowledge this fact. The increase in tonnage of shipping produced in the United States is demonstrated by the fact that since steam has taken the place of sails, voyages are made much shorter, consequently expenses are less, and thus by careful computation it is found that one ton of steam vessel is equal to three tons of sail; so that really there have been 72,000 tons of shipping furnished to the home market within twelve months past. Of the actual 24,000 tons of steam shipping built, 7,600 tons were for the foreign trade, thus disproving the statement that there was nothing being done for foreign trade."

This establishment also has advantages over any English yard. For instance, at the works of John Elder & Co., a vessel cannot be furnished complete for use, for the firm makes neither its own castings nor forgings. At another large English ship-building establishment the ships are built in Belfast, the iron plate comes from London, and the coal from Scotland. Only a few years ago, in this country, a steam vessel was a production of several establishments, and vexed questions often arose among contractors as to how far their work should extend, and damages were claimed for delays caused by other contractors. Mr. Webb or Mr. Steers would contract to build the hull; the iron works would furnish the machinery; the joiners would put in their work; the painter would paint the ship, the plumbers set the pipes, and the riggers rig the vessel. Now this complicated system is obviated by completing the vessel before she leaves the works where her keel is laid. At Mr. Roach's yard the iron is rolled into plates, the ship built, the engines, masts and rigging put in, the joiner work, bedding, upholstery, and in fact everything necessary to make a vessel ready for sea is furnished at the one establishment. The vessel then goes on her trial trip, taking not only the persons for whom she was built, but also a number of experts; and when she returns to the company's pier—as in the case of the City of Macon, a few days ago—the owners are asked if they are satisfied with the vessel and its appointments, and then, and not until then, is the title to the vessel transferred from the builder to the owner.

The large number of men employed by Mr. Roach represent twenty different branches of the work. At Chester 1,030 men are employed in the construction of vessels, 130 are under contract, and 450 are in the rolling mills. In New York he employs about 800 men. This is exclusive of foremen, and foots up in round numbers an aggregate of 2,500 men.

Mr. Roach thinks that the navigation laws, prohibiting the registration, in the United States, of vessels built in any other part of the world, ought not to be abolished. The demand for free ships, he says, does not come from American shipbuilders, but from English speculators. "I was approached a year or two ago," he states, "to use my influence toward having a law passed for free shipping; but at that time there were several iron vessels laid up in England, which had been cast aside as of no further

use, and it was the object of speculators to bring those vessels to the United States and dispose of them. In that way a large quantity of iron, copper, spelter, and everything that goes into the construction of a vessel, and which is heavily taxed, would have been brought here free of duty. Such a change in the law would also deprive the workingmen of this country of the labor which belongs to them, and absolutely kill the growing industry in ship-building of the United States. As the law now stands, it compels young shipbuilders to depend upon themselves, as there is iron and other material enough, which can be produced in this country, to build up the American shipping again, so that it will rank next to that of England, at least."—*N. Y. Tribune.*

Experiments with Ammonia and Flowers.—A French journal states that Professor Gobba has lately made a series of experiments for the purpose of determining the changes which ammonia produces in the colors of different flowers. For this purpose he merely makes use of a dish in which is poured a small quantity of common aqua ammonia. Over this he places a funnel, in the tube of which are inserted the flowers to be experimented upon. In this way he has shown that blue, violet and purple flowers change to a beautiful green; deep red carmine flowers to black, white to yellow, etc. These changes are most striking when the flowers have several different tints, in which the red lines are turned green, the white yellow, etc. An interesting example is that of the fuchias, with white and red flowers, which in consequence of the ammonia vapor become yellow, blue and green. If, when these changes have taken place, the flowers are immersed in pure water, they preserve their new colors for several hours, after which they gradually resume their original tints. Another observation due to Dr. Gobba is that the flowers of the asters, which are naturally inodorous, acquire a very agreeable perfume under the influence of ammonia. The flowers of the violet asters also become red when they are moistened with a diluted solution of nitric acid. Again, these same flowers, if exposed in an open box to the vapor of hydrochloric acid, become after some hours of a beautiful carmine red, which they preserve, after being dried in the dark, if kept in a dry, dark place. Our readers may like to try some of these experiments.—*Journal of Chemistry*, xii, 67.

A Contrivance for Rendering the Numbers of Houses Visible by night is becoming general in Paris. It consists of a hollow triangular prism nine inches long, two of whose sides are formed of panes of blue glass, on which the number of the house is picked out in white. This prism-shaped lamp-glass rests against the front of the house, so that the two sides with the numbers on them can be plainly seen by the passers-by. In the interior of the prism is a gas jet, fed by a pipe from the house. Householders on the Avenue de l'Opera have been obliged to supply this mode of numbering at their own expense on the houses they are building; and the municipal authorities have introduced it on some 450 of the municipal establishments, schools, police offices, fire-brigade offices, &c.—*Telegraphic Journal*, v, 283.

Birds with Teeth.—At the late meeting of the American Academy Prof. Marsh submitted for examination some of the elaborate drawings and engravings which will illustrate his forthcoming monograph on the Odontornithes, or Birds with Teeth. The work will contain about forty quarto plates, and will describe three genera, of which the types are *Hesperornis*, which had teeth in grooves; *Ichthyornis*, which had teeth in sockets, and had biconcave vertebræ; and *Apatornis*, which is allied to *Ichthyornis*. His specimens include thirty or forty individuals of *Hesperornis;* of the other about as many. These birds were discovered in the cretaceous beds of the West. Twenty species have there been found. In all Europe only two species of cretaceous birds have been discovered, and of these the remaina are mere fragments. A restoration of the *Hesperornis* by Prof. Marsh, shows a skeleton that is almost wholly complete in actual remains. The peculiarities of these cretaceous birds were briefly described. The *Hesperornis regalis* was a swimming, carnivorous, ostrich-like bird, of reptilian affinities, and incapable of flight. The *Ichthyornis* had, on the contrary, well-developed wings of enormous size.—*English Mechanic and World of Science*, xxvi, 299.

An Old Theory Exploded.—It is well known that when an animal is coated with an impermeable varnish, serious symptoms speedily ensue, which terminate in death unless they are relieved. There is an old story of a boy who lost his life by being gilded all over to represent an angel in some ceremony; but Herr Senator has quietly robbed that story of its usefulness, by showing that there was something poisonous in the coating and not the mere fact of a coating, that was the cause of death. Under his care two healthy men allowed their limbs to be coated with impermeable plasters, and the remainder of the body—the trunk—to be varnished with layers of flexible collodion. The men remained with this covering upon them for a week, without any consequences of any kind being observed. There was neither fall nor increase of temperature—no albuminuria, no dyspnea—in fact, nothing except perhaps discomfort, for the varnish and plasters could scarcely be comfortable.—*English Mechanic and World of Science*, xxvi, 233.

Iron Bridge Builders.—The contracts for the erection of the Gilbert Elevated Railway in New York have been signed. The road is to be three miles long, and the work has been divided between Clark, Reeves & Co., the Keystone Bridge Company, and the Edge Moor Iron Works. The New York Elevated Railway, another enterprise, is also soon to be commenced.

A call we have just made at the office of the Phœnixville Bridge Works, Clark, Reeves & Co., reveals a vast increase in the business of this company. Within the past few months, in addition to the contract for the Gilbert Elevated Railway, upon which they are now at work, they have either completed, or have now in hand the following iron bridges—For the Quebec, Montreal, Ottawa, and Occident Railway of Canada: one bridge of 6 spans, each 150 feet long; one bridge of one span, 129 feet long; one bridge of 4 spans, each 160 feet long; one draw bridge, 129 feet long; one bridge of 5 spans, each 218 feet long; five bridges, each 50 feet long; one bridge of 4 spans 3 of 150 feet, and one of 100 feet; one bridge of 5 spans, 4 of 150 feet, and one of 100 feet; and 3 bridges, each 100 feet long—in all 15 bridges. For the Grand Trunk Railway; two bridges, one of 24 feet, and one of 100 feet. For the Great Western of Canada; one bridge of 100 feet, and several small girder bridges. For a Cuban railroad; one bridge, 155 feet long. For the New London and Northern Railway; one bridge, of 2 spans, one of 96 feet, and one of 150 feet. For the Missouri Pacific Railroad, one bridge of two spans each 110 feet. For the Toledo Wabash and Western Railroad one bridge of 2 spans—one of 170 feet, and one of 150 feet.

The Philadelphia *North American* says another solid achievement in bridge building and engineering has been made by the Keystone Bridge Company, in the successful completion of the longest span of truss-bridge in the world. The bridge was built for the Cincinnati Southern Railway over the Ohio River. The first long span of truss bridge attempted in this country was the Ohio River bridge, at Steubenville, with a channel span of 320 feet. It was designed by J. H Linville, and manufactured and erected under his supervision. Then followed spans of 350 feet at Parkersburg and Blair, of the Linville truss; then the 420-foot span at Cincinnati, and the great steel arch bridge at St. Louis with several spans, one of 515 feet, two of 500 feet, and others shorter. These were all erected by the Keystone Company. The new structure was tested on the 8th inst. Five of the spans comprising the bridge proper over the Ohio, were built by the Keystone Company, and five others on the Ohio side, over the streets and houses, by the Baltimore Bridge Company. The former was also awarded the contract for the eleventh span and the bridge over Eighth street. The structure as it stands cost nearly $700,000. Span No. 3 over the main current is 519 feet long—the longest truss span in the world. The bridge is built entirely of iron, except the cross-ties for the track and the guard rails. All the spans rest upon solid masonry piers, except the north end approach, which has iron piers with masonry bases. All the river piers are upon a rock foundation. Those upon the shore are upon a foundation of piles. The two piers supporting the long span are 110 and 119 feet high, and 11 by 26 feet under the coping. The top of the rail is 105⅔ feet above extreme low water mark, and 43 feet above high water mark of 1832. The testing was performed with locomotives.

The Philadelphia *Evening Telegraph* says that an agent of the Russian government is in this city for the purpose of entering into a contract to bridge the Danube, and for that purpose visited the office of the Keystone Bridge Company, on Monday. The terms stipulated for a bridge of 2,100 feet in length, without a span, to be ready at the beginning of the spring. The Government was ready to spend $3,000,000, but the Keystone Company at once said that it was impossible to bridge the Danube without a span, and that it would also be impossible to complete it within the specified time.

The Keystone Bridge Company is building an iron bridge of thirteen spans over the Monongahela River, for the Pennsylvania Railroad.

If the Government will but aid this winter in the establishment of steamship lines to South America and other countries, our bridge-builders will send American bridges to every part or the world, and plenty of them.—*The Bulletin*, xi, 308.

MANUFACTURING AND INDUSTRIAL NOTES.

—Sharps' Rifle Company has a very favorable prospect of securing from the Chinese Government a contract for 1,000,000 of their new military rifles. Samples of the rifles manufactured by several American companies have been sent to China for trial, and we are informed that the government agent of China who visited this country on this special business, recommends the Sharps' above all competitors.—*Bridgeport Farmer.*

—The Holly Manufacturing Company, of Lockport, N. Y., bought of Dennis Long & Co., of Louisville, 2000 tons of water-pipe. for the new water-works to be built at Burlington, Iowa. The Little Rock (Arkansas) Water Company yesterday closed a contract with Long & Co. for the construction of the entire water-works at Little Rock. The price for the works completed is $110,000. Both contracts were awarded in competition with the other pipe works of the country.—*Iron Age.*

—The Washburn & Moen Manufacturing Company, of Worcester, are finding their early impressions with reference to the merits of steel barb fencing more than confirmed by the actual demand for the article. It seems to be as eagerly sought for in parts of the country where there is plenty of wood, as it is in the prairie States. A prominent feature in the barb fencing business at present is the demand from railroads, some dozen different railroads of the country having purchased and put up on the lines of their several roads over 200 tons during the last six months. The manufacturers say "it should not be difficult to find a ready market for a fencing which is cheaper and more lasting than any other, and which is the only fence that breachy and unruly cattle will not touch."—*Iron Age.*

—The Cambria Iron Company have nearly completed their new mill at Johnstown for rolling wire rods of Bessemer steel. They are also erecting a building around and over their present Bessemer blooming mill, increasing its size, and making a handsome brick and iron building in place of a wooden shed. The work of rolling blooms is carried on while the alterations are in progress. The new blast furnace is giving excellent results. The charging and gas-collecting apparatus, in which the gas is taken from the middle of the charger, a design of Mr. Daniel N. Jones, chief engineer of the works, is well worthy of inspection by furnacemen.—*Iron Age.*

—The new buildings of the Pittsburgh Steel Casting Co. (to replace those destroyed by fire last June) are now about completed. The main building, in which the melting, casting, fitting, etc., are done, is 256 feet long by 122 feet wide, in one span This building, in addition to being fire-proof, is of the most substantial character, the foundations of heavy stone, the brick walls heavy—nothing but hard brick used—and all the mortar seams poured solid with grouting. On these walls is erected the iron roof frame, 122 feet span, and it will certainly bear the criticisms of those competent to judge of this character of work. To light so large an area, in addition to the windows in side walls, are twelve skylights in the roof, each eight feet four inches by fifteen feet, the glass being set in iron sash frames. The roof and gables are covered with corrugated iron.—*Iron Age.*

EDITORIAL CORRESPONDENCE.

MESSRS. WAHL & GRIMSHAW, Philadelphia, Pa.

Gentlemen:—After many days, last week's POLYTECHNIC has just reached me. Have you changed its day or is some one at fault?

Either my pen or your proof-reader was out of order in producing my last letter in print, and I ask you to make note of the following errata:

In seventh paragraph, read "an error" instead of "*and* error."

In eighth paragraph, 17th line, read "office," for *official*.

In ninth paragraph, next to last line, read "because of *the impossibilities of*."

In tenth paragraph, 4th line, read "*contrivance*" for controversy.

In eleventh paragraph, 9th line, read, "Without such a"—. With these corrections I believe sense may be restored to the lines.

Mr. Howson does not appear to answer the argument of my letter, which, if you will permit me, I will formulate, and hope that we may hear from patentees upon the subject.

1. It is necessary that the patent shall make such a full disclosure, that any person skilled may construct and work the invention without further invention.

2. The value of the patent depends upon the assurance that this disclosure *is* complete *or can be made so by re-issue.*

3. It is as a rule impossible to procure this certainty *until a machine has been constructed.* The courts have repeatedly held that no invention can be considered as completed until the machine has been made and worked. Until that time there will remain an uncertainty.

4. The cost of producing *such drawings* as would establish the efficacy of the invention, would cost more than the model.

5. Under the most skillful hands, without a working machine there must ever remain an element of uncertainty which cannot be satisfied until a machine has been made.

6. Where the patent precedes the machine, and it is then found to be defective, there can not be any remedy.

7. The fact of this uncertainty will be a cloud upon the value of the patent.

8. *Any uncertainty as to the validity or sufficiency of a patent, is a detriment to the inventor and a corresponding advantage to the manufacturer or infringer.*

9. It seems impossible to establish any rule which shall determine beforehand, those cases in which models may be dispensed with.

10. The labor and expense of the official examination will be largely increased if models are not required.

11. As we cannot legislate the dishonest and stupid out of existence, we ought not to shape legislation so as to give them increased opportunities for harm.

12. The model is the *inventor's own record*, about which there can not be any mistake. The drawings and specification are the production of another, and constantly liable to error. Without this *contemporaneous* record, the validity and *authenticity* of which *cannot be denied*, the public would often be at the mercy of unscrupulous assignees and manufacturers.

Respectfully,

R. D. O. SMITH.

Compound Engines.

EDITORS POLYTECHNIC REVIEW:—

In consequence of my correspondence on the above subject in your issue of July 21st, and August 4th, I have received several communications, and find that the functions of an intermediate receiver of the independent Compound Engine are but imperfectly understood. It is generally supposed that when the cranks are at 90 degrees or 180 degrees it is to hold the stream exhausted from the high-pressure cylinder until the low-pressure cylinder is ready to take it; but it has more important duties to perform, as I will explain in the following.

In the Woolf Engine, (as that class of compounds is called, where the cylinders make their strike together, or are coupled to cranks) at 180 degrees the expansion takes place *between the cylinders* or rather *from one cylinder into the other*; as the clearance space between them is filled with steam if the pressure at the end of expansion, the fresh steam expands first into it and *so much of its action is lost.*

Pressure and temperature vary greatly in each cylinder throughout the stroke, hence great inequality of action and much condensation are caused, and it is impossible to arrange the proportions so that both cylinders shall do an equal share of work.

In the independent compound the expansion takes place in *each cylinder separately*, and the receiver ought to be so proportioned as to keep the back pressure in the high-pressure cylinder, and the initial pressure in the low-pressure cylinder as nearly uniform as possible. To enable this to be done the period of admission to the low-pressure cylinder must be limited; it is generally from one-third to two thirds of the stroke.

Then the *pressure* and *temperature* in *each* cylinder are kept within narrow limits, insuring *equality of action* throughout the stroke, and a minimum of condensation; with proper proportions both cylinders can be made to perform equal work, thus their working parts may be duplicates, and a uniformity of rotation is attained which is of special importance in marine engines, where no fly-wheel can be used.

The influence of clearance is greatly diminished, as the passages between the cylinders form only a small part of the intermediate receiver (in which no great variation of pressure occurs); and the *special clearance belonging to each* cylinder can be filled by a reasonable amount of compression, which (for obvious reasons) cannot be done with the intermediate passages in a Woolf engine.

The initial or maximum pressures in an independent compound, which, of course, determine the dimensions of the working parts and the throat upon the bearings—are not much greater than the *average mean pressures*, which fact secures *economy of material* and a minimum of friction.

The capacity of the receiver may vary greatly; it is generally from three to seven times the capacity of the high-pressure cylinder. A greater receiver would give a greater uniformity of pressure, but its greater weight, space, and surface for radiation of heat would make it objectionable. J. Haug, M. E.

NOVEMBER 23, 1877.

[OFFICIAL.]

INDEX OF INVENTIONS,

FOR WHICH

LETTERS PATENT OF THE UNITED STATES WERE GRANTED FOR THE WEEK ENDING

November 13, 1877,

AND EACH BEARING THAT DATE.

Those Marked (r) are Re-issued Patents.

A complete copy of any Patent in the annexed list, including both the specifications and drawings, will be furnished from this office for ONE DOLLAR. In ordering, please state the number and date of the Patent desired, and remit to

WAHL & GRIMSHAW, Publishers,
119 *South Fourth Street, Philadelphia.*

	Class No.	No. of Patent
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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, DECEMBER 22, 1877. No. 25.

ARTIFICIAL LEGS.

One of the distinguishing marks of the later and higher civilization is the endeavor to preserve physical welfare and the completeness of the person. The healing art, which snatches the sick from the clutches of death and carefully guards against undue removal or curtailment of any useful member in case of injury—is in marked contrast with the harsh practice in early days or of the modern savage (who kills the sick and maimed and aged to prevent their remaining or becoming a burden), and with the heroic treatment of the earlier leech, who hauled an aching molar or hacked off an injured limb, with equal *nonchalance* and with marvelous alacrity.

With later light, the tendency has been not only to give, but when losses are necessarily incurred, to supply omissions, for sightliness and service. The science of healing has a powerful adjunct in the newer art of *replacing*; and the latter has the powerful stimulus of having upon it (even more pressing than that of need), the demands of shrinking sensitiveness and of urgent, imperious vanity.

The dealer in artificial charms has ever driven a thriving trade upon the petty weakness of his fellows. His is far from an unjustifiable calling, although devotees have made it pander to the freaks of fashion. But he who gives new members for use and appearance should rank with him who saves their mates. Time was when not Daedalus' or Icarus' task was deemed less hopeful. Now, the results of their consummate skill are so widespread as to warrant our detailed consideration.

The most important artificialities which genius and experience have given the world, are serviceable limbs, raising the cripple to the dignity and usefulness (to say nothing of the mere appearance) of his fellow men.

The reapers of modern war gather yearly a goodly harvest of sturdy limbs; the Juggernaut of steam daily lops off its hundreds, whose pitiful stumps preach silent homilies against carelessness and cupidity. What are we now doing to repair the injury?

In early days, and in barbarous countries, when by chance the life of a maimed individual was spared, his deficiency was sometimes supplied in part by a peg or a hook for leg or arm; or a friendly crutch tendered its awkward aid. Locomotion was possible, but neither natural nor convenient. Among the earliest artificial legs was doubtless a bamboo trunk, or equally primitive socket, with simple prolongation, ironhooped to prevent splitting.

But perhaps before going into the history of artificial limbs we had better consider the actual nature of the demands imposed upon the giver of artificial locomotion.

Walking seems easy and natural—so does talking—but we must remember that each of these arts took us many months to accomplish; and the former has in truth great complexity and violence and a danger, overcome only by constant familiarity. In an article entitled "The Human Wheel—its Spokes and Felloes,"* our own genial Autocrat of the Breakfast Table has by instantaneous photography caught and pictured the various stages of this wonderful acrobatic feat, which every pedestrian has practiced (as Mons. Jourdain had talked prose) for so many years without proud consciousness thereof.

The human foot has lengthwise and transverse archings to give strength and elasticity; under the instep of the Castilian Senorita "water can flow without wetting the sole." At the ankle joint is is a loose hinge, swung by the great muscles of the calf. The *ballerina*, with shapely and steel-like muscles to flex this hinge, can stand upon the very tips of her toes; conversely the grisette owes her famed contour of limb to her habit of picking her way on tip-toe in narrow and gutterless streets.

The knee is a hinge-joint, with a "stop-motion" of two powerful crossed cords.

The thigh has a ball and socket (self-lubricating, like all other joints in the human machine) permitting the limb to vibrate like a simple pendulum, and like it, with a rate and force dependent upon its length and weight.

Fig. 1 *Fig.* 2. *Fig.* 3. *Fig.* 4.

To return to Dr. Holmes: In Fig. 1 we have a long stride, bringing almost vertical the right sole, which the calf has *rolled* off the ground while tipping the body forward upon the other foot. In Fig. 2 the right leg is bending at the knee so as to lift and swing the foot forward.

In Fig. 3 the *left* leg (as yet unstraightened) has swung in mid-air, rather more than half its arc. In Fig. 4 the foot has swung forward, tending to swing back the leg, the leg is straightened and the body tipped forward so that the heel touches the ground. The longer the stride, the greater the angle of the sole. Our boot-wear shows that the heel strikes heavily and the sole simply *rolls*. The motion is thus like that of a wheel, as shown in Fig. 5. At each step a man stoops, and consequently can walk rapidly under a rail lower than his head.

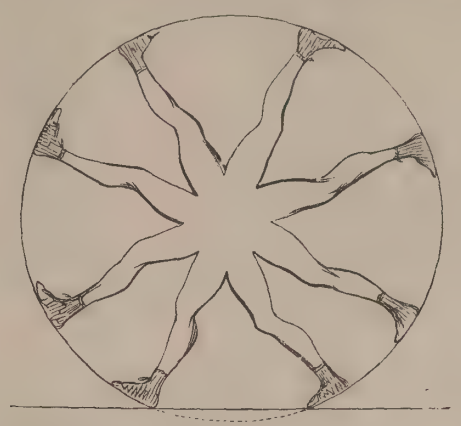


Fig. 5.

As yet, there has been made no automaton that can walk as a man walks, by *rolling*. The "*Autoperipatetikos*," or walking doll, and the Newark "Steam Man" alike, failed to imitate the "human wheel."† No automaton can shift its center of gravity from one foot to another.

So much for what is to be done. The "peg" leg or "stump" strapped to the thigh, permitted of an outward swinging or slinging motion, different from the hinging vibration of the natural member; and a man with one such wooden leg had one vibrating and one conical pendulum. When the amputation was below the knee (by far the most frequent case) the joint was flexed and the "ligniped" knelt in the socket, not having any hinge-joint. Indeed, all legs were for many years cut off close below the knee-joint; partly to avoid having too long a laterally projecting stump, and partly because it was until thirty years ago believed that one could not use that stump with safety.

In 1579, Ambrose Pare, the greatest of surgeons, describes and illustrates an artificial leg known in France and Italy, and very rude in character.

Verduin. *Verduin.* *Verduin.*

Fig. 6. *Fig.* 7. *Fig.* 8.

In 1696, the learned Hollander, Verduin, produced an artificial leg (shown in Figs. 6 and 7), having a wooden foot (*A*) on which were fastened two pieces of steel, going up to a level with the knee joint. The stump was encased with a padded *copper boot*, (*B*), riveted to the side-pieces. A thigh-case (*F*) laced over the front of the thigh, was hinged to the side-pieces (*H.*) A chamois stocking (Fig. 8) enveloped the stump up to the thigh. In this chamois sack or case, the stump was suspended with a view of sustaining a portion of the weight, which could not be done in *that manner*, and the theory was rejected for hundreds of years. Throughout the eighteenth century we find surgeons distributing the weight of the body upon both the thigh and the remaining portion of the lower leg.

In 1826, Serre proposed the small of the thigh as the point of support. In 1831, Goyrand proposed support at the perineum (or "crotch"). Mille, for amputation at a point above the ankle joint, modified the Goyrand device and attached to the stump itself. But notwithstanding the most earnest efforts of the mechanicians, the patient was by each of these constantly changing devices and supports, highly uncomfortable. Through the influence of Goyrand, the great surgeon Velpeau accepted the progress and amputated just above the ankle, giving the long stump, and a far less dangerous operation.

Mille stimulated Charriere to the construction of legs permitting easy walking in cases of amputation near the ankle joint. While Martin engaged to produce one allowing those amputated at the "inferior third" (one third the distance from the ankle to the knee) to walk, rather than to "stump it." But Martin, seeking to protect the end of the foot in walking, raised the toe (see Fig. 9); this brought the weight always on the heel, and produced "*stumping*"; so that a lock join

*Atlantic Monthly, May 1863.

†The "*remigio alarum*" or "oarage of the wings" of birds has been demonstrated to be a true rotary motion simulating the action of a screw propeller.

had to be put in the knee to keep it straight and stiff in walking. The foot was of so little consequence on this leg, that he made one footless style for poor people. Charriere preserved the

Martin. *Mille.* *Charriere.* *Mathieu.*

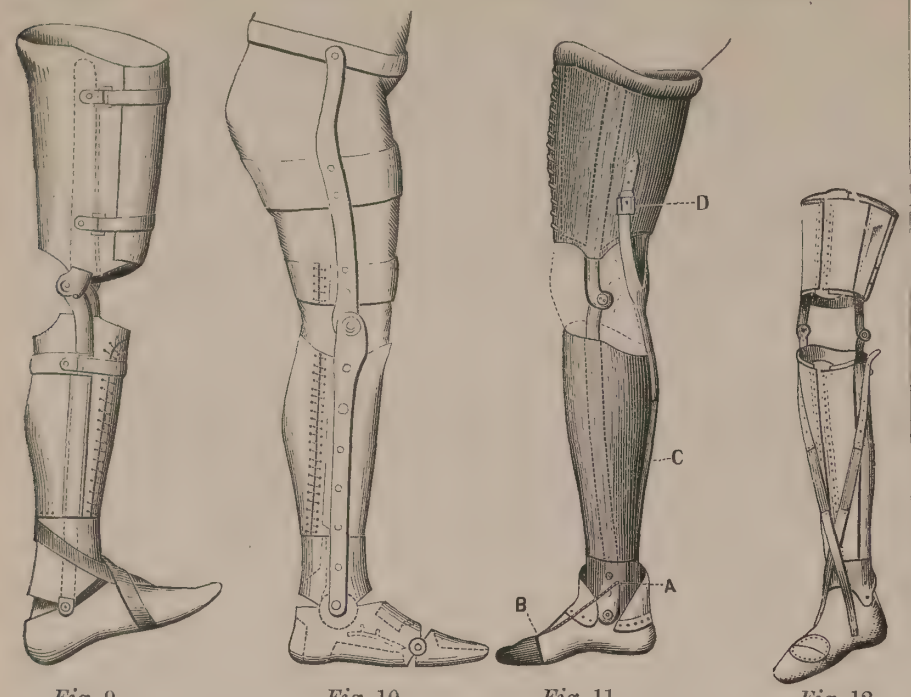


Fig. 9. *Fig.* 10. *Fig.* 11. *Fig.* 12.

foot, as did Mille (Fig. 10), producing flexion and extension of the end, by springs. In his model of 1856 (Fig. 11) the extension of the foot is maintained by an artificial muscle (*C*), extending from the heel (*A*) to the lower and back part of the thigh-socket *D*. The legs of Mathieu and Bechard are shown in Figs. 12 and 13; they have as a base two pieces of leather-cased steel; and springs which raise the foot, make the device, like that of Martin, superior to the "peg" only in sightliness.

Bechard. *Palmer.*

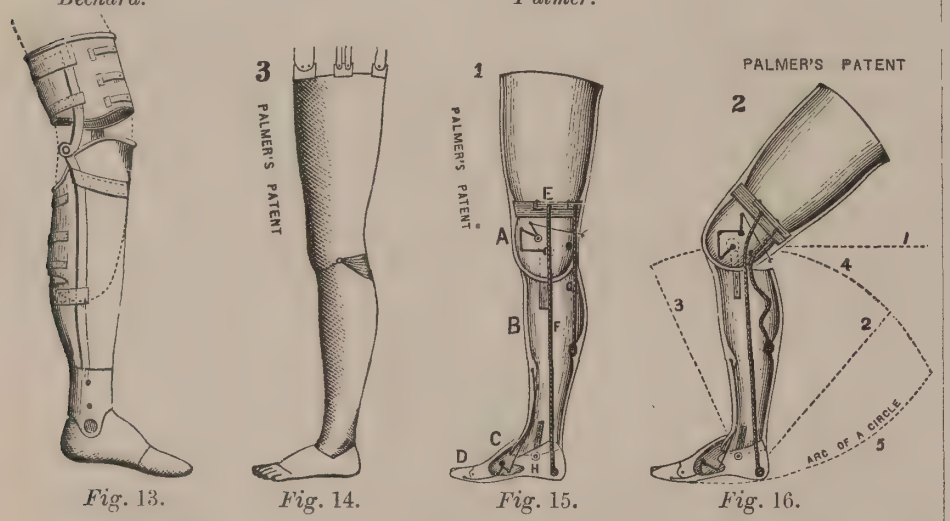


Fig. 13. *Fig.* 14. *Fig.* 15. *Fig.* 16.

British makers were more enterprising and successful than the French. In 1790, Thomas Mann produced a leg of hollowed wood, chamois covered; having leather-bushed (and hence noiseless) joints, whose motion was aided by thigh and foot springs. In 1800, James Potts produced for the Marquis of Anglesea, a leg since known as the "Anglesea." It had a leather socket; a locked hinge at the knee, giving stiffness in standing; a ball and socket at the ankle; and a hinged toe-piece. In 1810, Mann added to his leg of 1790, springs and cords, giving greater naturalness to knee and ankle movements, and aiding the wearer in straightening the limb after flexure, while also allowing of continued flexure while sitting. In 1816, Strand made a "spring-joint" to give elastic tread. In 1807 Wilms made the frame of layers of cartouch paper and linen. In 1853, Mitchell got up a leg without internal mechanism, but operated by tackle rigged to the hip. In 1850, Palmer patented rubber springs, and in 1852 published in his "Cane and Antidote" the possibility of walking on the end of the stump—citing cases. In 1856, Ashman introduced a spiral heel spring, and suggests hide, papier-mache and vulcanite for framing. In 1857, Newton, an Englishman, patented a leg having elastic tendon cords from thigh to foot, and also (in case of amputation above the knee) an inner pouch to hold the stump and save it from the tendency of the ordinary taper socket, to strain and burst the cicatrice.

But this mode of support was the same as that tried in 1579 by Pare, and proved a failure, as a pouch or sack for a cushion always resists; their action being such as to increase the evil rather than to remedy it.

Of American patents there are about 150; nearly all of these are worthless, and many of them ridiculous, impractical, or even dangerous. The first in point of time and importance, prior to 1873, were those of B. F. Palmer, in 1846, 1849, and 1852. Regarding this we take from the celebrated work of Velpeau, the following cuts and description of this first really great advance in Prosthesis. See Figs. 15 and 16.

"The articulations of knee, ankle, and toes, consist of detached ball and socket joints, *A*, *B*, *C*. The knee and ankle are articulated by means of the steel bolts, *H. H*, combining with plates of steel firmly riveted to the sides of the leg, *B*, *B*. To these side plates are immovably fastened the steel bolts *H. H*. The bolts take bearings in solid wood (properly bushed) across the *entire diameter of the knee and ankle*, being stronger, more reliable and durable than those of the usual construction. All the joints are so constructed that *no two pieces of metal move against each other in the entire limb*. The contact of all broad surfaces is avoided, where motion is required, and thus friction is reduced to the *lowest degree possible* These joints often perform for many months without need of oil, or any attention—a desideratum fully appreciated by the wearer.

The *tendo Archsllis*, or heel tendon, *F*, perfectly imitates the natural one. It is attached to the bridge *E*, in the thigh, and, passing down on the back side of the knee bolt, *E*, is firmly fastened to the heel. It acts through the knee bolt, *on a centre*, when the weight is on the leg, imparting security and firmness to the knee and ankle joints, thus obviating all necessity for *knee-catches*. When the knee bends, in taking a step, this tendon vibrates from the knee bolt to the back side of the thigh, Fig. 15. It descends through the leg, so as to allow the foot to rise above all obstructions, in flexion, and carries the foot down again, in extension of the leg for the next step, so as to take a firm support on the ball of the foot. Nature-like elasticity is thus attained, and all thumping sounds are avoided.

Another tendon *G*, of great strength and slight elasticity, arrests the motion of the knee gently in walking, thus preventing all disagreeable sound and jarring sensation, and giving requisite elasticity to the knee.

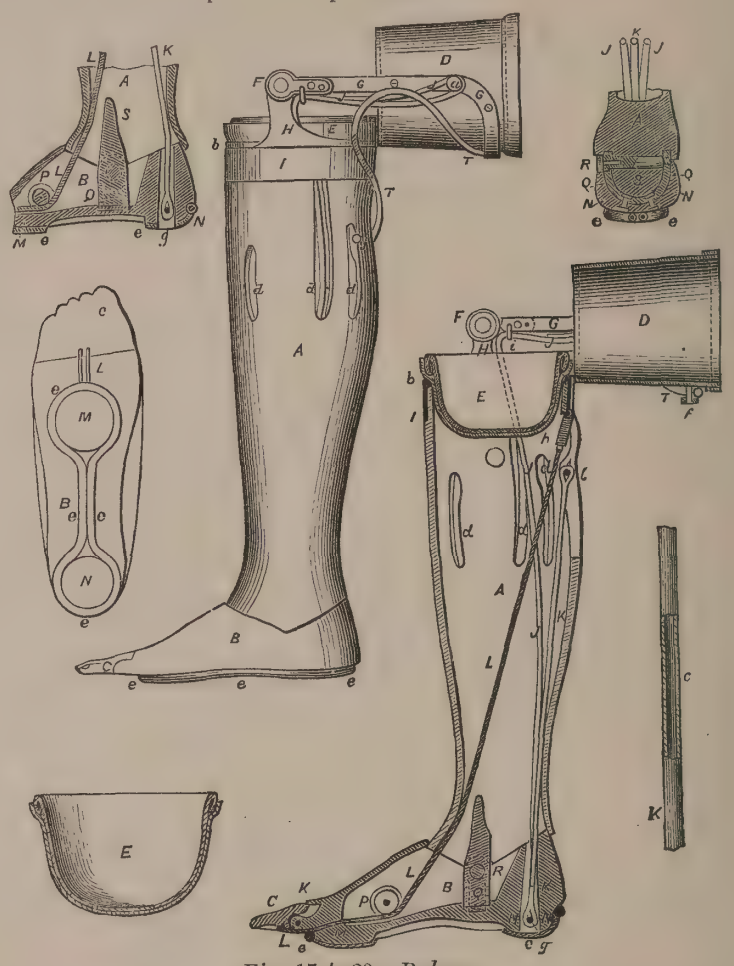
A spring, lever, and tendon, which combine with the knee bolt, give instant extension to the leg when it has been semi-flexed to take a step, and admit of perfect flexion in sitting.

A spring and tendons in the foot, also impart proper and reliable action to the ankle joint and toes. The sole of the foot is made soft, to insure *lightness and elasticity of step.*

The stump receives no weight *on the end*, and is well covered and protected to avoid friction and excoriation. Fig. 16 is a view of Palmer's perfect model."

But however admirable the Palmer leg of 1846-52, the same inventor in 1873 completely reversed his own teachings and practice and those of surgeons and all other makers, by a successful development of the method which he tested in 1852, but then only accepted as possible in exceptional cases.

This new invention is of so great importance as to have been pronounced the mos remarkable advance in this department of prosthesis.



Figs 17 *to* 23—*Palmer.*

Just here the reader should pause and notice just what this great triumph consists in. It may, in a sentence, be said to be the practical embodiment, and happy application to the noblest purpose, of the grand thought of the great Pare—three hundred years ago—which, hitherto, though of transcendent importance, has been lost to the art. Pare was right theoretically, but practically his mechanician failed, and the mechanical failure was fatal to the theory. The mechanism of Palmer, is wholly different, hence his success. Pare attempted the use of a copper boot, padded, and the auxiliary chamois sacks, and all other experimenters, till Palmer sought the support in a similar way. "Whenever the suggestion of this method of support has been made by other inventors, it has evidently been done on theoretical grounds alone, and the only apparatus proposed was a flexible leather sack, entirely unsuited to the purpose, and indeed directly calculated to endanger the safety of the stump at every step by forcing back the integuments and tending to bring the entire weight of the wearer upon the end of the bone over which they are stretched, by the elongation of the sack itself. When the sack receives the weight its form becomes that of an inverted cone, the interior apex of which is occupied by the end of the bone, while the soft tissues, which in their natural position surround and cover the bone, are pushed back into the base of the cone. Such an apparatus, far from advancing the establishment of the principle of end support, was calculated to postpone it indefinitely by proving that method to be dangerous if not impracticable. The safety-socket, on the contrary, is a kind of drum-head of leather made to fit the end of the stump exactly, and is so held and guided in the interior of the shell of the artificial leg that it is incapable of changing its form by the changing weight to which it is subjected in walking. It keeps its place securely on the stump, and does not allow the integuments to be subjected to any change of strain, or any change of place, by reason of the movements of the leg in walking. Thus it acts as a shield and protector for the stump, guarding it against shocks, and, by keeping the relation between the bone and the soft parts uniform, promoting the health and development of the muscles of the stump, and preserving the cicatrice from injury or rupture.

This safety-socket is now in use by a large number of patients, whose testimony is uniform that it can be worn even on a short and tender stump, taking the weight on the end not only without inconvenience or pain, but with a new sense of comfort and security. Many of the wearers were before us in person, and the testimony of many others was submitted, leaving no room for doubt as to the great superiority of this apparatus. The wearers describe it as

being perfectly comfortable, as affording greater control over the artificial limb, and giving to the end of the stump a sensation much resembling that felt on the heel and bottom of the natural foot, and relieving, in a great degree, the nervous sensitiveness which is usually so great a cause of suffering if it be amputated." Himself amputated just below the knee since boyhood, the inventor had never used his knee-joint, which for thirty-eight years had been rigid and unbending. By a remarkable exercise of intense will-force and of manipulations, he rendered his knee perfectly flexible and useful; and then it occurred to him to try what the great surgeons and every person similarly unfortunate had pronounced in the highest degree impossible, dangerous, and absurd, to bear the full weight upon the end of the stump—a portion about which most unipeds are so careful as "almost to be afraid to trust the bed clothes against it." The Doctor succeeded in bearing his own (quite heavy) weight full upon the heretofore carefully guarded stump-tip; and, having accomplished this feat, developed his "safety socket"—simply a piece of soft firm buckskin (stretched across the frame work), as a diaphragm, on which the stump is rested "full and firm." The danger of bursting (which really might exist where the taper socket strains the skin over the end of the bone) is here removed, as may be shown by folding a piece of tissue paper over the stump, in the taper socket it will be strained and burst, between the stump and the diaphram it is simply squeezed and not injured. Figs. 17-23 fully illustrate the new device, which has, despite its radical departure, won after severe test, the highest encomiums of wearers and surgeons.

Taking a general survey of the field, we find that as mechanical devices many of the legs were improvements over the peg, only in that they could be bent while sitting. Many of them badly chafed and cramped the limb. Running was impossible. Regarding the materials, the rawhide cases were apt to lose rigidity if wet; steel and other basket work was not rigid, and dangerous in case of breaking; vulcanite and gutta percha are heavier than hollowed willow wood, which seems best adapted for this service. The use of catgut cords give naturalness and elasticity to the gait, but atmospheric influences interferred therewith. Many of the joints were noisy and stiff; some of them permitted of motions not attainable save by the boon of nerves to reach down thereto from the brain of the wearer.

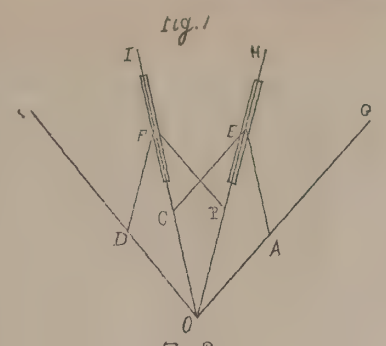
With the latest devices, illustrated above, the wearer can walk, run, ride, row and dance.

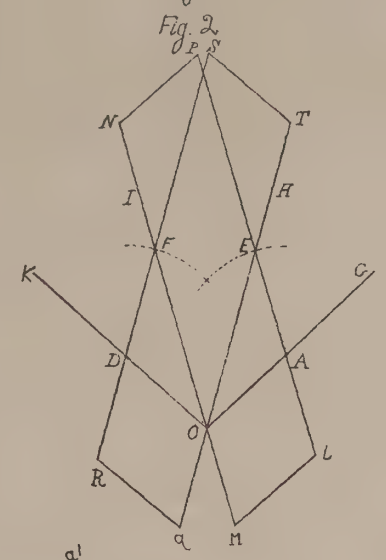
It is estimated that there are at least from 50,000 to 75,000 unipeds in this country, many of whom have been restored to usefulness and comfort by some form of artificial legs. Our most celebrated maker above, Dr. Palmer, has produced about 10,000 in his experience of thirty-one years.

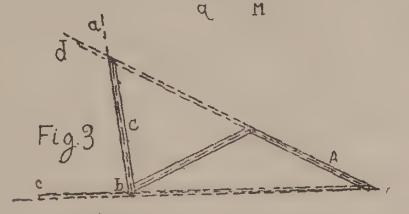
History gives us record of many distinguished men, who were unipeds; Hood has introduced in literature, "Miss Kilmansegg, and her Golden Leg," and we recall, on the moment, quaint Uncle Toby, whom Tristam Shandy records as stating so often that "The army swore terribly in Flanders." And finally Von Clam, of Rotterdam, owned that famous unstoppable steam leg, that walked him to destruction by dashing him against a lamp post—and for all we know (unless it has encountered that immovable object which is often quoted in connection with the "irresistible body") is emulating the Wandering Jew and the Flying Dutchman in circling the globe—the very demon of unrest. G.

‡Centennial Report.

MECHANICAL TRISECTION OF AN ANGLE.







Mr. Warren Holden proposed, in the *Scientific American*, a pair of compound compasses of four legs, so connected by levers that at every position of the compasses the second leg will bisect the angle formed by the first and third, while the third bisects that formed by the second and fourth; the angle formed by the first and fourth being then trisected.

In Fig. 1, *OG*, *OH*, *OI* and *OK* are the legs; *AE*, *CE*, *BF* and *DF* are connecting rods pivoted at *A*, *B*, *C*, *D*, united by pivots at *E* and *F*, and moving in slots on the legs *OH* and *OI*.

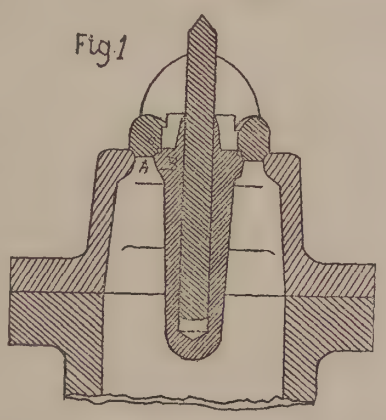
Fig. 2 shows a method of trisecting by two pairs of parallel rules. Lay off $OA = OD$, and with the same radius and *A* and *D* as centres, draw two axis.

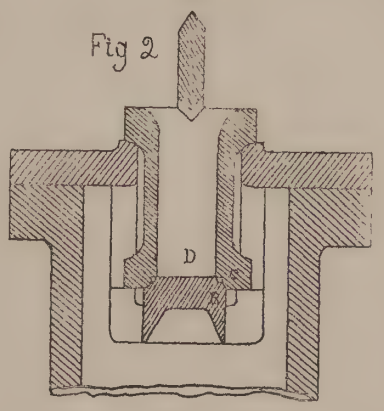
The point *E* of the line *OH* will be found on one arc, and point *F* of the line *OI* on the other arc. Drive pins at *OA* and *D*. Bring the inner edges of the parallel rules *LMMP* against the pins at *A* and *O*. In like manner bring the inner edges of the parallel rules *Q*, *R*, *S*, *T* against the pins at *O* and *D*. Then keeping the rules against the pins, move them around until *LP* intersects *QT* on one of the arcs, and *MN* intersects *RS* on the other arc. Then draw lines along *QT* and *MN*, and the angle will be trisected. It will be seen that *LP* and *RS* also intersect each other on the line bisecting the given angle—a fact which will serve as an additional guide in bringing the rules into position. Completing the parallelograms *OAEC* and *ODFB*, as seen in the first figure, the proof is the same.

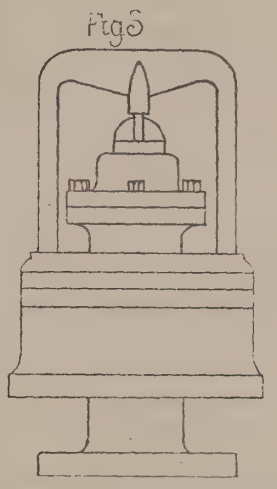
In the same journal, Mr. D. Matte shows the instrument, Fig. 3, in which the triangles 1, 2, 3 and 2, 3, 4. being isosceles, the angle 2, 1, 3, or its equal $doc = \frac{1}{3}\ abc$. The instrument being applied to the angle *abc*, as shown, *dob* will be the third required. A slight addition to this instrument would make a device for finding squares or square roots.

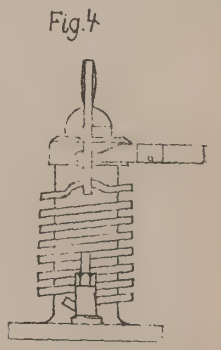
IMPROVED SAFETY VALVES.

The accompanying illustrations represent the improved safety valves invented by J. W. Milling, of Birkett Bank, Wigan, England. The principal feature of the valve is the increase of discharge area as compared with ordinary valves, obtained by increase of lift and by furnishing two openings for the escape of the steam. The former is obtained by providing a larger area for the steam to act on when the valve is blowing off than when it is closed.









Engineering gives the following description of the action of the valve. Referring to Figs. 1 and 2: "When blowing off, the steam that passes the inner face, *B*, acts with effect on the additional surface provided by the part *C*, on the valve. The width of the space left between this part *C* and the top of the boss on the seat, determines what amount of increase in pressure the valve will allow before rising to its full height; for instance, if a valve was loaded to commence blowing at 60 lbs., it would act something like an ordinary valve until the pressure reached say 62 lbs., when it would rise at once to its full height; but if the escape was made wide, it would allow the pressure to rise to 63 or 64 lbs. before going to its full height, which is, when loaded by dead weight, about equal to the width of the orifice in the seat; so that the area given for discharge is as much as is required by that orifice. In addition to the discharge, there is the inner one that is equal to from 30 to 40 per cent. of the outer one, and the combined areas amount to six or eight times as much as would be given by the ordinary kind of valve of the same diameter, when working with pressures over 50 lbs. per square inch. It will be seen that the discharge from the outer face is uninterrupted, whilst the inner discharge gives these valves an additional advantage when used as reducing valves, where the difference required in the pressures is small. These valves also overcome the objection to spring-loading, as the increasing resistance of the spring is compensated for by the additional area that is provided for the steam to act upon. These valves also differ from the ordinary safety-valves, as the lift is as great with high as with low pressures of steam.

The lift of the valve shown in Fig. 1, when loaded by dead weight, is self-regulating, as the steam lifting the valve has first to pass through the orifice in the seat; but with Fig. 2 the lift has to be limited. These valves may be so proportioned as to give a large discharging area with a smaller loaded or lifting area, which makes them specially valuable when used as combined low-water and high-pressure valves.

Fig. 3 shows the simplest and most direct mode of loading for stationary boilers, the weights being carried by the crossbar or stirrup, the socket of which fits loosely on the end of the valve spindle.

Fig. 4 is a representation of a spring-loaded valve in which the spring fits round the body of the seat, and at the top is held at each side by the projections on the collars that fit round the screw studs by which the tension is regulated. For marine purposes, Mr. Melling adopts an arrangement in which a pair of valves is mounted on the same branch seating. The valves are loaded by means of two springs, one at the end of the crossbar, and the tension of the springs is regulated by means of nuts on the screw studs at the bottom, or in place of the springs two ordinary spring balances are used; in either case the springs are out of the direct current of the escaping steam. The valves, when locked up, are eased from their faces by the double lever and double cam."

DETECTION OF BUTTER-ADULTERATION.

To detect whether butter has been mixed with inorganic or animal fats, P. Jaillard places a thin film between two strips of glass and examines it microscopically. If the butter is pure, only fatty globules can be seen; if it is adulterated, there will also be crystalline ramifications in greater or less quantity.—*Les Mondes.*

ANOTHER "FIVE-DOLLAR" IDEA.—CASE HARDENING

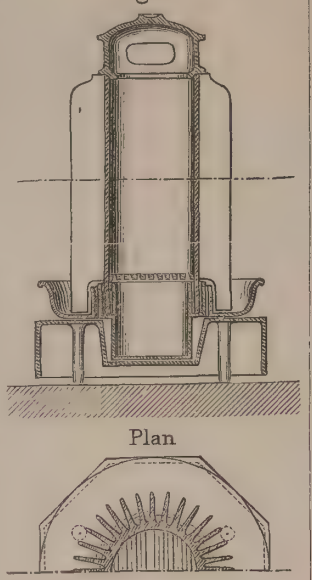
In case-hardening iron to a considerable depth, the unhardened portion is weakened by crystallization. This difficulty may be completely remedied by first hardening as usual, then annealing the articles the same as if of steel, in which operation the iron will assume its original fibrous structure; then harden, and, if required, temper the same as steel. J. E. S.

WARMING AND VENTILATING.*—II.

In our previous article we discussed the question of ordinary and ventilating open fire-places. We shall next consider that of STOVES.

The domestic stove, placed within the room, is the most economical mode of heating. When made of porcelain, sheet-iron or cast-iron, without hot air passages, they give out 85 to 90 per cent. of the useful effect of the fuel, (see Fig. 11). But as the amount of air passing through the stove and up the chimney is but about 80 cu. ft. per pound of wood, from 96 to 112 cu. ft. per pound of coal, and from 160 to 192 cu. ft. per pound of coke; even with a brisk fire these stoves produce but slow change of air, say $\frac{1}{10}$ the capacity of the place warmed, effecting complete change of air but once in ten hours. Stoves are then unhealthful. They are also injurious in causing marked differences in temperatures at different heights in a room—as much as 18° or 20° in a room 13 to 16 feet high.

Fig. 11.



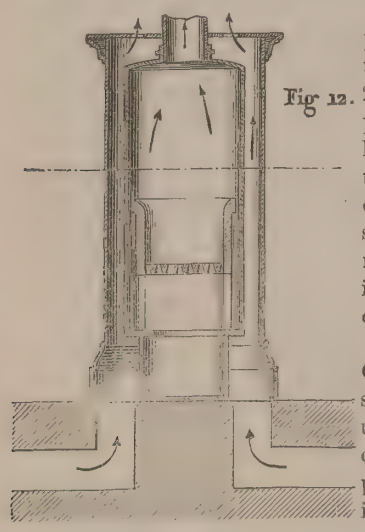
Plan

Cast-iron stoves are more injurious than porcelain, on account of the great and irregular heating of their sides. As usually made, they should not be used in dwellings. The experiments of H. Deville and Troost showed that cast-iron at a red heat readily allowed the passage of gas (especially hydrogen and carbonic acid); thus explaining the very injurious and even poisonous effects produced in dwellings. At first they should be used for passages and rooms seldom used, or easily changed in air.

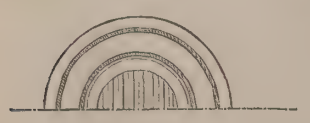
More recent improvements in cast-iron stoves permit of the opening of movable doors or the removal of blowers, so as to convert them (after the fire is started) into grates detached from the wall, and able to produce (with sufficiently large chimneys) ventilation similar to that in ordinary fire-places.

The insertion of an easily renewed fire-brick lining prevents the overheating and rapid destruction of the metal, and lessens the injurious effects of the stove.

Fig. 12.



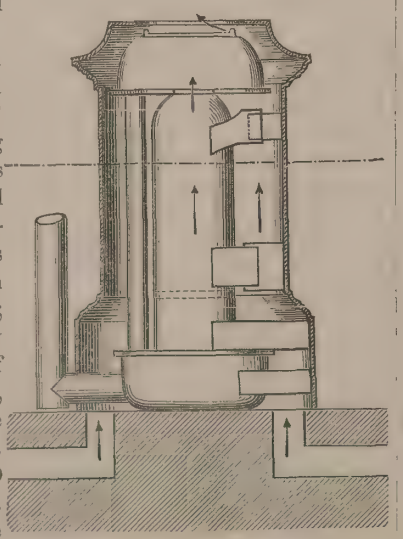
Plan



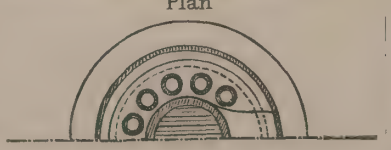
Stoves, with circulation of hot air effected through pipes and passages, are even more unhealthful than the last, as the air from these is frequently more than 212°. If the hot air passages and the draft be supplied from the external cold air, so that a part of the heat is employed to warm this air, the useful effect of this apparatus will be slightly increased, because the escaping gases will be cooler; but the hot air will still be at an unhealthful temperature; and the removal of foul air will be diminished rather than increased, on account of the diminished temperature of escaping gases.

A model devised by René Duvoir and the General Gas Light Company, and used in many Parisian schools, is specially recommended for coke-burning; utilizing 67 per cent. of the useful heating effect. The escaping gases have, at 13 feet from the fire, a temperature of 750°, the warm air passing into the school is as high as 392°; its volume being only 800 cu. ft. per pound of coal burned, on account of the insufficient size of the passages. Stoves of the usual proportions produce a change of but 2,119 cu. ft. per hour, or 352 cu. ft. per pound of coal. They are consequently unhealthful and unmeriting the name of "ventilating stoves," given by some makers. To make them cheap, such stoves have generally but 20 times as much heating as grate surface; when they should have from 60 to 80 times. The area of the hot air passages is scarcely equal to that of the grate; it should be three or four times as much, to increase the amount of air and lessen its temperature. The chimney area is but 18 per cent. that of the stove; this, if doubled, would secure more rapid change of air, but the heating effect would be materially reduced.

Fig. 13.



Plan



Portable heaters, of the Chaussenot model (Fig. 13), are for large rooms, hall-ways, &c., and while being "stoves with hot air circulation," they are true heaters; because, before escaping into the air, the products of combustion pass through many pipes; and there may be obtained a considerable amount of air, drawn from the outside of the building. Their heating effect reaches 93 per cent. They introduce and warm for each pound of coal, 2,551 cu. ft. of air at 266° or more; thus indicating insufficient passages. They remove but 91 cu. ft. of foul air for each pound of coal burned; and are consequently unhealthful, and suited only for warming passages, &c., where the external air may mix with the warmed air. The total heating surface in one tested was 100 times the grate surface; a good and large ratio. The air passages had three times the area of the grate; not quite enough. The chimney area is 47 per cent. of the grate area; enough for draft, but not securing sufficiently rapid removal of foul air.

The principal defects of all stoves (without exception) are:

(1) Not carrying off foul air as quickly as healthful. (2) Giving too high a temperature to the air passing through them.

These faults may be lessened by:

(1) Making separate ventilating drafts heated directly by the stove and the chimney. (2) Enlarging the hot air passages and taking the air from the outside of the building, so as to prevent it entering at doors and windows.

(3) Furnishing stoves with doors, which (after kindling) can be opened, thus almost making of them open fire-places, and causing a strong draft into the chimney, the size of which should be enlarged without fear of too much increasing the expense for fuel.

In some cases, where there is no flue above the fire-place, the smoke must be carried to a horizontal passage below, which conveys it to the bottom of a vertical flue some distance off. To obtain sufficient draft in lighting, it is generally necessary to start a small fire in the opening in the horizontal passage at the foot of the flue, causing a momentary draft, the external supply of air to this fire being stopped as soon as kindled; so that, taking air from the horizontal passage alone, it may produce a current to the chimney or the stove. This arrangement is often insufficient.

In houses lighted by gas it is preferable to introduce into the chimney at the occupied story, and not at the level of the lower horizontal passage, gas jets in a little metallic chimney $9\frac{3}{16}$ to $11\frac{3}{16}$ inches high, with separate air supply to prevent it being extinguished by the smoke.

Three or four jets, each consuming 4 cu. ft. of gas an hour, are enough. Their heat produces in the flue an increase of temperature, which keeps up the stove or chimney draft. They may be put out after the fire is kindled. G.

(To be continued.)

*[Translated and abridged from the French of Gen. Morin]. These cuts are kindly loaned by the Smithsonian Institute.

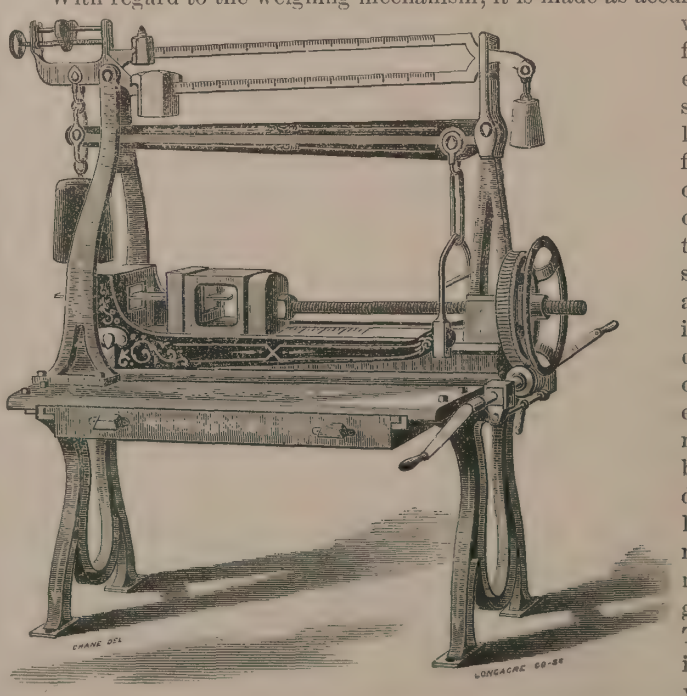
TESTING MACHINES.

The Testing Machines made by Riehlé Brothers, which are gaining such a widespread reputation among manufacturers and scientific men, have merits which warrant a description of them. The illustrations we present to our readers represent their 40,000 lb. machine for testing materials by tensile, transverse and crushing strains, and their 20,000 lb. horizontal machine. The principle of construction is simple and easily understood. All their machines, large and small, are made on the same principle—that of the power pulling directly in a perfectly straight line against an accurate weighing mechanism, with the specimen intervening.

The levers, which have steel knife-edged fulcra and steel bearings, possess the peculiar advantage of remaining in a horizontal position continually: the weigh-beams have only sufficient movement to distinctly indicate the pressure. Either screw or hydrostatic power is employed, as the case may demand. In the larger machines, on account of the quickness and case of operation, the latter has been adopted.

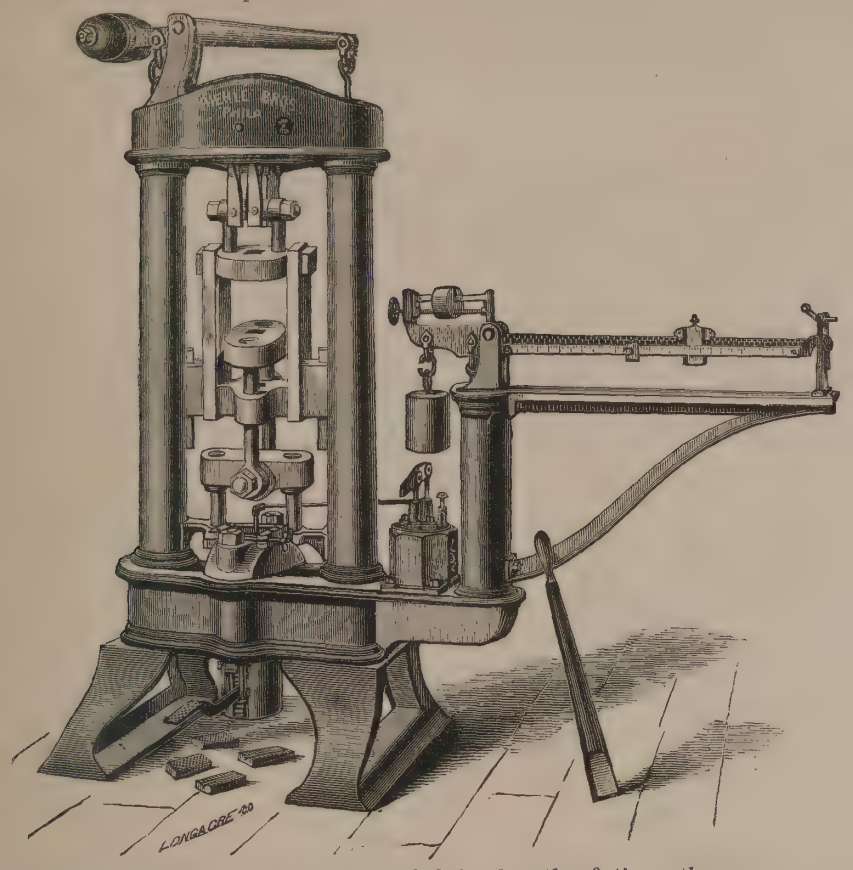
The 40,000 lb. machine is particularly noted for its compactness of form and the readiness with which the change from tensile to crushing or transverse power, or *vice versa*, can be effected. Another highly important feature is the absolute certainty that the strain will be perfectly central upon the specimens, whatever strain be applied. Of course proper care is necessary in operating this, as in any other machine, no matter how perfect it may be; but by adjusting the specimens properly the strain will be central, as all the levers and vibrating parts for transmitting the strain to the scale beam are suspended on the knife-edges universally used for weighing-machinery. This not only insures a minimum of friction, but also a perfect self-adjustment of the several parts. Thus, in gripping a specimen for tensile test, it is only necessary to have the heads of the taper-jaws at the same distance from the socket, to bring the specimen precisely in the centre of strain. For transverse tests, a block having a facial angle of 45° from perpendicular is placed in the upper socket, presenting an edge of 45° upon top of the specimen, resting upon permanent supports at the ends. In placing specimens for crushing strain, they are brought central by means of concentric circles on the lower block. The tools for holding the tensile specimens are either the ordinary appliances or wedge grips. By the aid of the latter, which are mostly used, round, square or flat specimens can be introduced into the machine without any preparation other than the mere reduction of the specimens to the proper length.

With regard to the weighing mechanism, it is made as accurate and positive in its working as any scale for weighing materials; even more care, if possible, is taken with the leverage, in placing the fulcra and getting them of sufficient length and of proper proportions to resist the shock resulting from the breakage of specimens, which is effected in the most quiet manner and without injury to the knife-edges. Poises which readily run along the beams are used, thus doing away with all loose weights. This arrangement permits the making of tests with great ease and rapidity. The following simple instructions indicate the working of the machines: Insert the specimen in the grips, open the valve of the pump. and work the



handle up and down, watch the rise of the beam, and move the poise forward; keep the beam in equipoise, and the strain is shown continually on the beam. On the smaller machines the beams are marked in pounds, on the larger one in ten-pound notches.

The 20,000 lb. horizontal machine was designed for testing band-iron, but is equally serviceable in testing all kinds of materials of suitable shape, &c. The power is exerted by means of a steel screw, which is operated by cogs and worm-wheel gearing, or can be adapted for power with a pulley and centre-shaft. It can be thrown in and out of gear instantly, and the screw pulled back and forth at pleasure to suit long and short specimens, without the tedious operation of turning the screw backward and forward when no strain is being applied. The beams are double, and are provided with gravitating poises. There are two grooved wheels behind the centre on the inside of the poises, which have the tendency of throwing the knife-edges into the notches and holding them there. A patent balance-ball is another improvement for keeping the machine in balance. The surface or bed of the machine is graduated so as to record the stretch of the specimens.



For light strains, to be held an indefinite length of time, the screw power is commonly employed, but in heavy work where quickness is desired, the hydrostatic power is preferred.

The colleges and polytechnic schools of the United States are beginning to purchase these machines for the lecture-room, as the officers of these institutions are fully awakened to the benefit the student derives from actual demonstration. The impression made by a test of iron or steel, for instance, in the lecture-room, will be deeper and more lasting than that derived from dry and conventional dissertation on the subject.

English data have, hitherto, we believe, been accepted as correctly applying to the strength of our products, which experience has shown, however, to be incorrect, and has probably been the cause of many of the recent disasters. J. C.

THE CONDITION OF THE POTTERY ART IN THE UNITED STATES.

With the abundance of excellent natural material existing in the United States, cheaply afforded to the hand of the manufacturer, it is not remarkable that the development of the industry has been wonderfully rapid, considered also in connection with the fact that the American manufacturers had the advantage of being able to employ the most skilled foreman and workmen ever trained in Europe. With this allowance the result realized is very creditable to the energy, enterprise and ability manifested through the progress of the enterprise upward from plain delft and bulky goods to the fine granites and higher grade.

The chief centers of pottery enterprise and successful production in the United States have been Trenton, Greenpoint, Philadelphia, East Liverpool, Ohio, Cincinnati and elsewhere. In decorated goods the proficiency has not been equal to the expectation. The principal productions are granites, C. C. or cream-colored wares; Parian is also produced, but not largely. The granite ware, resembling the stone china of English manufacture, is an earthenware of white body, fired at a high temperature and covered with a thin, hard glaze. In the best specimens the body is extremely close, compact and hard; the glaze thin, well incorporated, very hard, and not liable to "craze." This ware is capable of bearing, without injury, sudden transitions of temperature, and in the hands of some manufacturers the preparation of the material, and the turning out of the ware, have been carried to great perfection. In no instance has this feature been so successfully attained as in the remarkably unique work of the Laughlin Bros., East Liverpool, Ohio. The advance made by them in the last few years has been immense, the wares being generally of excellent body and glaze, showing a great goodness of the material used, and a high quality attained in the formation of what may almost be called a new body in pottery wares.

As regards the history of pottery in the United States, coarse and bulky wares were manufactured in the country at an early period, probably reaching back to the middle of the last century. As far back as 1760, seventy potteries of a better class were established, and gave such promise of success that Wedgewood, writing about that date expressed his apprehensions as to the effect of them upon English "trade and prosperity." In 1769, porcelain works were begun in Southwark, Philadelphia, which existed for several years; but of these works, unfortunately, little is known. The small potteries of the war period of 1812-15, nearly all quickly suspended with the ensuing peace. The goods were coarse and badly glazed. About 1830, a porcelain manufactory was started in Philadelphia, in which was practically shown the possibility of making, in commercial quantities, a hard porcelain of good and serviceable quality, by using such materials as were most accessible to the sea coast. This concern was a commercial failure, notwithstanding the products were white and decorated table and tea services and ornamented pieces. These were sold at reasonable prices by an establishment in Philadelphia, dealing mostly in them. The sales at one time reached to a considerable amount for the period. The body of this porcelain was sound, brilliant, of great toughness, and with a hard glaze. The principal hindrance to the goods was the unskillfulness of the decoration. These decorations were mostly in flowers and other similar subjects, somewhat stiffly painted in rather dull colors. This manufactory closed after a few years, leaving considerable loss to the enterprising and praiseworthy founders. Subsequently, and at intervals, other hard porcelain works were established on much smaller scales, generally for the production of door-plates, door-knobs, etc., and for cups and saucers and other small pieces. With the exception of the partial success attending the introduction of restaurant wares of uncommon weight the success was indifferent. From the experience in these it is hoped may arise large and valuable manufactures, in which fine forms and decorations will be developed when art museums and art culture shall have been established at the centers of industry.

Many attempts with varying success, were made to establish gray and yellow stone and Rockingham goods; and about 1850 this branch of the business appeared to be seated on a firm basis. White granite ware does not reliably date beyond 1854, and was not well established until 1864. These goods were imitations of the true English white granite wares, and undecorated. After some failures and much loss, and by persistent and praiseworthy efforts, lasting through several years, this important manufacture was established about the year 1866, and was made a commercial success a few years later, and the resulting product is the present white granite "body" of the United States. For several years, without apparent reason therefor, the trade marks of well-known English houses were used, and in so far some of these laudable efforts and successes were stained with misrepresentation. At the present time, however, this bad and mean feature is nearly abolished, and the makers' names and addresses are used, much to their honor and credit.

All the manufacturers produce an article nearly enough alike to come under one general statement of features and qualities. Mr. R. H. Soden Smith, in a report, thus described the character of these goods:

Firstly, as to "body." It is very white, hard, and dense, being partly vitreous or vitrescent, and, for earthenware, having but little porosity and showing great plasticity; it may be rather too hard for the production upon it of the finest soft underglaze colors, particularly in printed patterns (which are now made in these wares mostly by printing over the glaze,) though this will doubtless be amended if necessary.

NUMBER OF POTTERIES.

These wares more nearly resemble the hardest English white earthenware than any other "body," but are harder than those, although not so hard as the vitreous "ironstone china, made many years ago by Mason, and afterwards by Messrs. Morley & Co., and others, of Staffordshire. The entire freedom from spots of iron or other impurities is remarkable in this "white granite" body. The glazes are generally of good medium hardness, varying somewhat with the different makers; they are well incorporated with the body, and show but little tendency to "craze" (or crackle,) and it is claimed by the American manufacturers that their glazes are more free from this defect than those of the wares of other countries. They are full and transparent, with good capacity for receiving colors, quite equal to any observed, more particularly in the muffle hard fire colors, which in these glazes and upon this body come out very evenly and richly. It is perhaps to be regretted that a trade demand causes both body and glaze to be too much overcharged with blue, thereby injuring the color of the wares and of the decorations placed upon them, and this too, at an additional cost to the manufacturer. The forms of these wares are mostly made with a view to popular sale, being copied or adapted generally from the French and English. They are suitable for their purposes, and the ornamentation of handles and covers is fairly good. As a rule rather more care might be taken with the fittings of covers. It is to be regretted that so large a proportion of this really excellent body and glaze should be devoted to the use of heavy, thick, and coarse cups and saucers, plates, dishes, and other pieces demanded by hotels and restaurants, and even by private families throughout the United States. But several pieces of remarkable thinness and delicacy, made by Mr. Isaac Davies, of Trenton, were shown, which evinced a high degree of plastic quality in the material the same as that used for the heavier pieces, and also showed a very considerable skill in pottery. These last named pieces are especially commendable as an advance in taste, and as a clear demonstration of the value of the "body."

The decorations as a rule are, as might have been expected in so young a manufacture, deficient in originality, being copied mostly from the English or French. Generally they are suitable for their purposes, but are not of a high order, and often overdone; but there are some exceptions where good taste and judgment are shown. Some modeling done in Trenton, is clean and careful, evincing considerable skill and knowledge. The prices of these wares, particularly of the large pieces, are low in relation to the cost of labor in the United States. The processes employed in this manufacture are of the most improved kind, and the potteries, many of which were seen by the judges, are well arranged, very orderly, and highly commendable; all the materials used are found in the United States, and generally within a short distance of the several works throughout that country.—*M. M. A. & R. Journal.*

ERRATA.

In the description of the improved water-back for fire places, patented by George Moore, of Lynchburg, Va., published in issue dated Oct. 29, we neglected to state that the water heated in the "back" is circulated by means of pipes through the house, and thereby serves to warm the same. In the foot-note appended to the same article the address should read Lynchburg, *Va.*, and not *Pa.*, as there printed.

YUFTS OR RUSSIA LEATHER.

It is astonishing the quantity of leather goods that are sold as *Russia Leather*, and are in reality but a poor importation having, for the time being, an odor resembling the genuine article.

It seems curious that we are not able to manufacture this leather with the same result as in Bulgaria, where it was first discovered; it may be that the birch bark made use of has not the same composition; or again, they may have secrets which, up to this time, remain unknown. Consequently it is possible that the odor of this delightful leather does not come from the oil of the birch bark alone*.

The advantages of being water-tight, not mildewing, and never being attacked by insects are important items in the manufacture of "*Articles de Luxe.*"

The name Yufts is derived from the Russian *Justi*, meaning fair, in consequence of the method adopted for dyeing, which greatly resembles Drake's method of tanning.

In the "Bulletin de la sociètè d'encouragement de l'industrie Nationale," Count Kartsoff gives various methods of tanning as now existing in Russia. The manufactories of importance are at Orlow, Moscow and Wladimir, the government establishments are at Cazan.

The dried skins are softened by soaking in water for 5 or 6 days. They are then deprived of hair by steeping in milk of lime (185 lbs. of lime being mixed with water in a vat of a given dimension) for heavy skins a method similar to the cold sweating now existing in Pennsylvania is adopted, they are placed in an oven, spread one on the other, and are covered with earth so as to prevent fermentation.

Soaking, washing, beating with the feet are the next operations, they are then rinsed in warm water until it runs clear, then placed in a running stream for two days.

The tanning now commences. To facilitate the entrance of the tannin into the pores of the skin, swelling is necessary; a bath composed of rye flour and salt mixed with water is made use of. The skins are now exposed to a weak infusion of willow bark and are then stratified in a vat with layers of course bark, the vat being filled with the tanning infusion first used; the whole contents are now pressed down with planks, on which are placed heavy stones, and are left in this position 15 to 28 days. They are then taken out and again stratified with fresh bark. This is repeated 3 to 6 times, according to the nature of the skins—greater the thickness the longer they remain.

The leather has now a certain stiffness, which is got rid of by soaking for 2 days in a paste composed of oatmeal, salt and warm water; washing, and then drained, and they are now ready for oiling (which is done with a mixture of fish-oil and tar from the birch bark). The skins being in a moist state, are placed on a table with flesh side up. The application of the above is done by hand, the oil is thus spread over the entire surface; the quality of the skin depends upon this operation. If it be desired to have the skin as white as possible, (for red and yellow dyeing this is necessary) to the pure oil is added a little beef tallow, ½ lb. being sufficient for an ordinary skin.

The skins are spread on ropes under well aèrated shade, where they remain until perfectly dry. Feschertrœm described some 75 years ago, a method similar to the above. A factory was then established in France, which did not prove successful. After a series of experiments made by Payen, they have arrived to manufacture a leather which resembles Russia leather.

Hides of calves are most generally made use of, but frequently other skins are utilized. They are cleansed in the ordinary manner with lime, and are swelled in an acid bath composed of malt and exhausted tan liquor.

The solution is made weaker and weaker. The skins remain in this bath some 48 hours, afterward placed in vats filled with water for 15 days, then washed in the river.

The skins are now placed in a bath of a warm infusion of birch bark, at a temperature sufficiently low not to destroy the animal fibres; they are then stirred and pressed during the first half hour; this operation is repeated twice a day for a week. The decoction of birch bark is renewed every week; the skins are stirred and pressed as before; the whole operation of tanning lasts about 6 weeks.

The skins are now exposed to the air to dry. The tanned hides are then impregnated with an oil called *elachert*, obtained by distilling in a copper still, similar to those used in the manufacture of pyroligneous acid; the empyreumatic oil having a certain color, a rectification is necessary. The above is Duval's process. Payen's method greatly resembles the one spoken of by Fischerstrœm. The whitish membranous epidermis of the birch is separated from all the woody matter introduced into an iron boiler, covered with a vaulted iron lid, from the centre of which issues an iron pipe; over this boiler another is placed, in which the tube enters without touching its bottom; the edges of the boilers are bolted and tightly luted. They are then inverted: the lower half of this apparatus is sunk into the earth, and then the surface of the upper boiler is covered with a lute composed of clay and sand; and then surrounded with a wood fire, and exposed to a red heat until the distillation is finished;) the absorption of this oil will be greater when the hides are not entirely dry. Care should be taken that too great a quantity be not used at a time, fearing that it will penetrate the entire thickness of the hide, thus causing spots to appear on the other side; (this is generally the case, as can easily be seen upon examination of the Russia leather in our market;) it is made to enter the skin by rubbing.

The hairy side is also rubbed with a solution of alum, and grained and dryed.

This leather is generally dyed either red or black, and sometimes yellow.

The composition of the red color, with which this leather is commonly stained, has not been accurately ascertained; it generally contains Brazil wood, alum and other substances.

It is not durable, will not resist the action of boiling water, remains unaltered in the air.

Black Russian leather is obtained in the same manner as the red, the only difference being in the chemical made use of in dyeing this color, as obtained by a repeated action of acetate of iron or pyrolignite of iron. The yellow can he obtained with mild chamomile.

The *Kirghises* prepare their skins with smoke instead of tanning; the skins are strongly stretched when green and hair taken off. They are placed in a pit, the bottom of which is a tunnel which communicates with another pit, in which a fire is made; the smoke is obliged to penetrate inside the pit that contains the skins. After some 15 or 20 days of smoking, the skins are impregnated with the volatile products of the combustion. They have in this manner gained some of the properties of tanned leather.

The grain, before spoken of, in Russia Leather, is a diamond shape. The skins are made to pass through a cylinder of steel, covered with a number of close parallel threads or grooves cut perpendicular to its axis. The skin is first placed lengthwise and longitudinal grooves are impressed by the track of the cylinder. The skin is again placed on the bench crosswise, or at an angle according as it is intended to give a square or diamond-shaped grain.

Sandal wood, of late years, has been greatly used for dyeing red; to this we must add many attempts to attain an imitation of Russia leather. Mr. Wagmyster, a tanner at Paggstall, attained some success.

The leather manufactured in Russia and elsewhere in imitation, is applied to various purposes, such as book-binding, portfolios, pocket, blank and memorandum books, souvenirs, instrument cases, &c., being covered with it.

The price of this leather on our market next year, to all probability, will be higher than it has been for some years past in consequence of the war with Turkey.

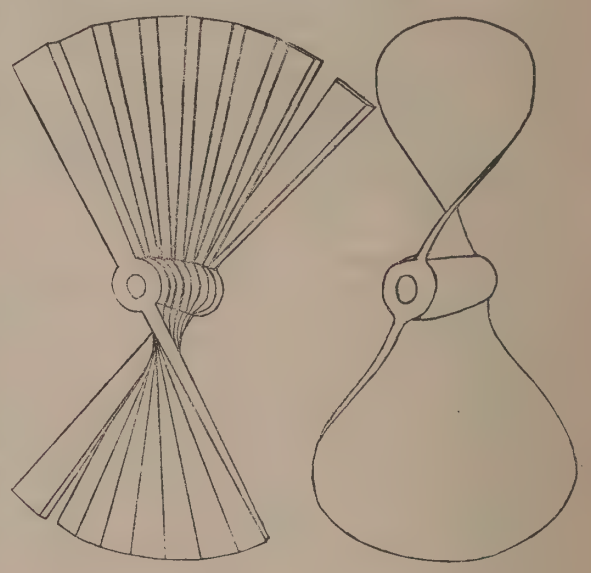
LEWIS S. WARE, C. E.

*Payen & Chevalier have examined the epidermis of the birch-bark, and discovered a white substance soluble in alcohol; when thrown on incandesent charcoal gives a white vapor, which greatly resembles the aromatic odor of *Russia Leather*.

NEW METHOD OF MAKING PROPELLER PATTERNS.

We give herewith an illustration of a new method of making patterns for propellers, so as to get a turn screw by mechanical means, without the necessity of calculation and drafts. The new method was designed by Mr. Otto Osten, a mechanic of San Francisco. As shown in the engraving, a number of pieces of wood are planed to the same size, and placed on a piece of iron, threaded on its upper end, so that a nut may clamp them together. They are then spread out to the required pitch and marked on both ends with a pair of compasses. All the wood outside the marks is then taken off. The pieces are smoothed up, clamped and glued together, and the pattern is made. After being clamped, the pattern is narrowed at the hub and rounded at the tips to make it neater.

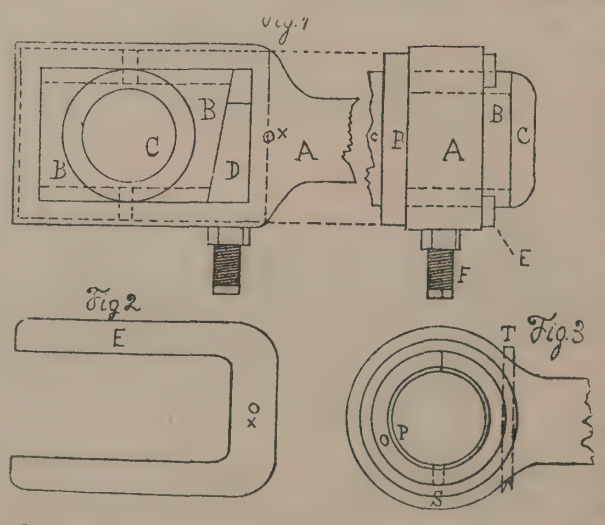
This gives all the curves true, with no guess work, as is too often the case with the method in vogue. It ought to reduce the cost of propellers, as the pattern is so simply made. Propeller patterns are the most difficult jobs to do around a foundry; a true screw is difficult to make, and then they are not always sure of being correct.



Several propellers have been made as samples from this style of pattern.

After the pattern is made, before it is glued together, the purchaser may examine and see if the pitch suits him; or he can set the pieces of wood before the pattern is made and get exactly the pitch he wants. Where it is desired to have the propeller curve inwards at the tip to prevent slip, the pieces of wood are made a little thicker at the tips so that the screw can be made accurately. We have seen several of the patterns made on this principle, by Mr. Osten, all of which were very correctly made. Any ordinary mechanic can make one, as it takes no scientific knowledge to prepare plans and drawings, before the pattern makers take hold of the work.—*Mining & Scientific Press*, xxxv, 113.

SOLID ENDED CONNECTING RODS.



Mr. F. G. Woodward, of Lawrence, Mass., proposed in the *Scientific American* some time ago, to employ connecting rods forged in one piece, with simply an opening in the end for the reception of brasses. This usage is not frequent in stationary engines, and never used in locomotive practice. The figures show a rod intended for locomotive use. The openings for the reception of brass *B* must be wide enough to let through it the collar of the wrist *C*; the brasses have flanges only in their inner ends, so that the rod *A* may be slipped on them after they are placed on the wrist. The wedge *D* may then be put in, and the steel binding plate *E* slid into place as shown at *E*, end view, *Fig.* 1. *Fig.* 2 shows this plate detached; a small binder is applied at *x* to keep the plate in place. The screw *F* and wedge *D* follow up the wear of the brasses. *Fig.* 3 is a good form for parallel-rod ends; the outer ring *O* being large enough to let the wrist-collar pass easily through the eye; the ring *P* being simply a composition ring.

The outer ring is secured by a lining split taper pin *T*. A dowel *S* keeps the inner ring from turning.

G.

"TEN MINUTE" PAPERS.

TOOLS AND THEIR USES.—XIII.

BY PROF. J. E. SWEET.

Among the tools which may be considered as permanent fixtures to the lathe, in addition to the face-plate, which should be perfectly true, there is required either a small face-plate with a slot for the "tail of the dog," when such dogs as we use are employed, or a spider with four slots. The face-plate, with a single slot, possesses the advantage that in screw cutting the work can be removed, and when replaced it is in the same place. The advantage of the four slots, if accurately spaced, is that they can be used for cutting double or quadruple threads, by simply changing the "tail of the dog" into the different slots. If one of the slots were made characteristically different from the other three, to use for ordinary screw cutting, the four-slotted spider would be the best.

Our American method of using the dog, or driver, or carrier, is crude and unscientific; but we stick to it because it is convenient, and I presume we will until some one invents an equally convenient one that is better. The projecting tail acts as a lever tending to bend the work out of true, and always does so when the work is light. The bad effects of this one-sided driver can often be seen by the works chattering during one-half of the revolution and turning smooth on the other. The English improve upon this by using a dog without a tail and call it a carrier, and use a pin or stud in the face-plate or spider as a driver. This, too, is a one-sided driver, but there is less tendency to bend the work. The correct thing is the Clement's driver, which, as usually constructed, consists of a secondary face-plate fixed upon the primary one, by two screws passing through slotted holes, leaving the second plate free to slide for a short distance across the axis of the lathe. Projecting from this plate are two studs, set upon opposite quarters from the slotted holes. The two ends of the carrier coming in contact with the two studs receive equal impulse; because the second plate is free to slide upon the first, and so slides over until it drives equally on each end. A different arrangement of this same principle is shown in Fig. 18. Putting it in this form makes it lighter, and it can be quickly removed.

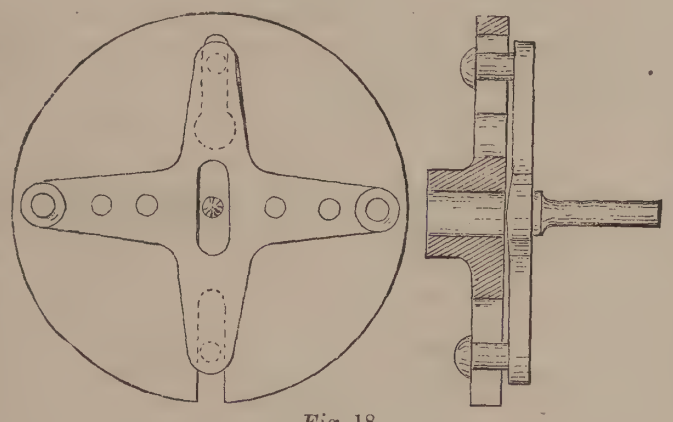


Fig. 18

Any kind of device secured to the main spindle of a lathe, and used for holding pieces of work, is called a chuck, and they are about as various as the classes of work to be operated upon. The universal and the independent jawed chucks are the most common. Combined chucks, of which our Oneida chuck is a fair sample, are coming, to a certain extent, into use. Of the universal chucks, that is those in which the jaws are moved to and from the centre simultaneously, the Horton chuck, used on our milling machine, is probably one of the best. In these chucks the aim is to have them so perfect that a truly circular wheel may be grasped in the jaws and run true; but absolute truth is such a difficult thing to attain, a little dirt and wear are such hard things to avoid, that the best of chucks are liable to be only tantalizingly near perfection. Of the independent jawed chucks those having the jaws reversible are the best, and I think the arrangement of screws and jaws in the Oneida chuck the best I have seen.

To make a perfect combination of the universal and independent, there is one unsurmountable difficulty. The universal should have three jaws only, the independent four jaws. In most of the combination chucks I have noticed, it would only take a few pieces more to make two complete chucks, and both good ones, in the place of the combination which does not fill either requirement completely.

Of the other chucks, other than those used for drills, blocks of wood often serve a useful purpose. The English use what they call a belt chuck; it consists of a cast iron drum, four or five inches in diameter and five or six long, threaded on the spindle of the lathe, and usually with eight set screws, four at each end. All regular or irregular pieces that will go inside can be secured in one of these contrivances, and in any way required—concentric, eccentric or skewed. In the matter of chucks for holding small drills there has been much thought expended, and it is a good study to go through with the argument in favor of the different kinds. The Little Giant has the merit of taking in large sized work, so that while it serves as a drill chuck it also answers for many other purposes which the other chucks do not. From the nature of its construction, it seems difficult to make the jaws of anything but case-hardened iron. This, to be sure, is the material used for most all the large chucks, but as usually made it does not compare in endurance with tempered steel.

Our tool makers must sometime learn the art, practised by the Bank Note Company, of tempering steel without changing its size, shape or color; then they can make jaws of tempered steel. When chucks receive as much punishment as we and most others give them, anything less enduring than tempered steel for jaws, screws and wrenches soon gives out.

The Victor chuck has the merit of giving a terrific grip; the jaws can be adjusted if they wear out of true, and the resistance of the drill tends to tighten it; but as to this last feature, which some other chucks possess also, there is this on the other hand, if the drill sticks and one attempts to get it out by turning back (the most natural thing to do) the tendency is to loosen it.

The Stetson improved Beach chuck, manufactured by the Morse Twist Drill Co., has the merit that as the jaws are closed down the screw is not exposed, which is a good improvement, for this was a drawback to the Beach chuck. Both this and the Victor, manufactured by the Victor Sewing Machine Co., are fine pieces of workmanship, and how they can be produced at the price sold for is a marvel to me.

Beside the operation of grasping things in a chuck, the clamping of pieces to the face-plate of the lathe is sometimes, if not usually, called chucking. In this, different workman favor and practice different methods. The common practice, I think, is not the best. In securing a six-arm pulley to the face-plate, workmen usually take four or six blocks, straps and bolts for the job; while three blocks under alternate arms with the binding straps exactly over the blocks, is a far better plan. No matter how securely the pulley is bolted, no strain is put upon it; and it can be bored, turned and, if the rim is not to be turned on, the inside finished at one setting. And the work can be done much faster while the pulley is on the face-plate than when on a mandrel, unless a Clement driver acting upon opposite arms be used.

Very few machinists appreciate the advantages gained by the use of a little solder. Often irregular pieces can be soldered to a block or casting, and chucked easily; and after finishing, a little heat melts it loose. I have seen various straps, bolts and clamps put around the two halves of a brass box to hold them for boring out, when the application of a little solder would have held them together like a solid box. It is well enough to remember that if you have a piece of work which you can neither chuck on the lathe nor hold in the vise, to solder it to a piece you can hold. In setting work in a four-jawed chuck, much time is saved in adjusting it first in one direction, that is by adjusting the first and third screws, entirely disregarding the other two; then when the piece is true in one direction, turn to the second and fourth screws and adjust those in like manner.

The head-stocks of lathes are not always true, that is holes bored in work chucked in the lathe are not parallel. Very often a tapering hole can be used, if it is largest on the right side. If the lathe naturally bores tapering with the large end of the hole wrong, use a boring tool that cuts on the back side and run the lathe backwards. In boring conical holes in a lathe having a pivoted head-stock, or with the compound rest, it is necessary that the cutting point of the tool be level with the centre; for if it be either above or below, the result will be a curved surface instead of a true cone. To understand the reason of this, it is only necessary to consider that a conical surface, if continued sufficiently far, would come to a point; a turning tool, if too high or too low, would not turn a piece to a point.

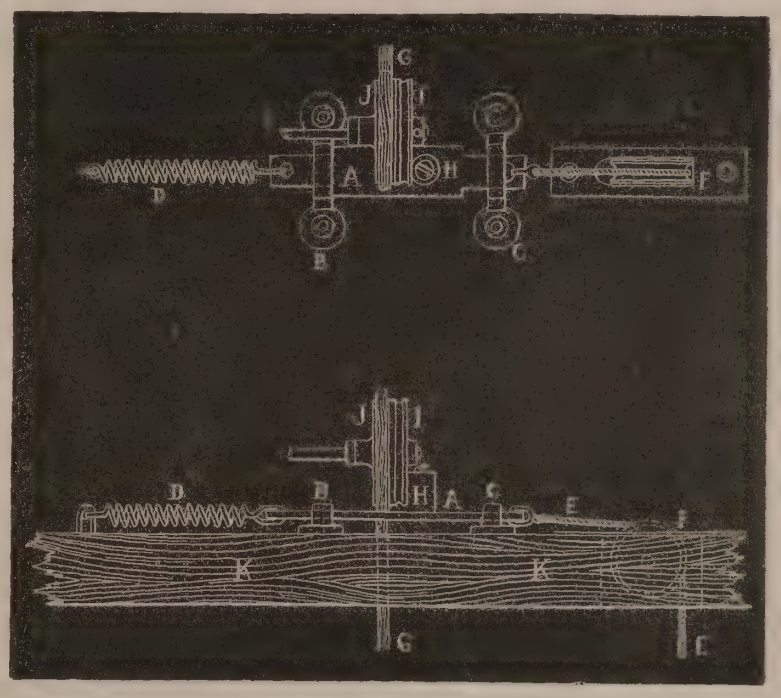
To be Continued

BELTING.*

COMBINED STRAP-SHIFTER AND STOP-MOTION

In the use of sewing-machines it is as necessary to stop them instantly as to drive them rapidly, particularly for manufacturing purposes, where a speed of some 6,000 stitches per minute is made, and where the machines are repeatedly started and stopped for changing the direction of the seam as well as the pieces to be sewn.

The cut illustrates a little device which answers this purpose so well that it deserves



a record among the good things employed in the best use of belting.

The shifting-bar *A*, guided by the staples *B* and *C*, secured to the table *K*, has a notch in its side for embracing the round belt *C*, which drives the machine, and carries a break *H* of leather, secured by an adjustable screw to the bar, and in such a position that when the cord is on the loose pulley *J*, as shown, the brake is held firmly against the tight pulley *I*, by the spring *D*, which is always in action.

To start the machine, the foot of the operator is pressed upon a hinged treadle, which is secured to the floor, and attached by a chord *E* to the shifting-bar, the direction of its motion being changed by a pulley *F*, also fixed in the table *K*. This action draws the brake *H* from, and puts the belt on, the tight pulley *I*, at the same time distending the spring *D*. When the foot is lifted, the recoil of the spring pulls the belt over on the loose pulley and holds the brake against the tight pulley, instantly stopping the machine and holding it still, without attention or effort of the operator, until motion is needed again, which the simple act of pressing the foot produces at will.

LEATHER PULLEY.

As there is "nothing like leather" for many purposes, especially in many places where there is much rubbing and at high velocities, it has occurred to many, perhaps, and the transition of thought seems natural indeed, that if leather will endure so much wear and tear at the circumference of a wheel, it must resist a like action at its axle, and therefore it would make a good bush for a loose pulley, or, where small, the whole pulley might be made of leather. Accordingly, this has been done with good effect; leather discs were bolted together, bored out, turned off, soaked in oil, and put in place as if made of iron in the usual way.

* Extracted from "The Use of Belting," by J. H. Cooper, M. E., (Claxton, Remsen & Haffelfinger, Philadelphia, Publishers.)

HISTORY OF TIN.

An English paper has recently given a very interesting history of the metal tin, from which we take the following facts: In Numbers xxxi, 22, Moses mentions gold, silver, iron, lead and tin. The Hebrew equivalent of this word is Bedil. It occurs in three other places in the Hebrew Scriptures. Once in Ezekiel, xxvii, 12, where Bedil is mentioned with silver, iron and copper as an article of Tyrian commerce; once in Zachariah, iv, 10, where the plummet of the builder is said to be of Bedil stone; and once in Isaiah i, 25, where the word seems to mean slag or scoria. The Greek and Latin equivalents of Bedil are Cassiteros and Stannum. It is nearly certain that these words, where they occur in the translations of the Bible, do not mean tin, but a white, heavy alloy of lead and silver. Pliny, in his "History of the World," describes the process of smelting lead as it was carried on in his time (A. D. 6 or 8.) Two kinds of lead were then known. One was made by simply heating the ore, which at once gave a good marketable product. This was called Plumbum Nigrum (black lead.) The other kind was made from a different ore by a more complex process. The ore was stamped, washed, roasted, made into a paste with water, and then fused in a furnace. The first fusion gave a regulus, which was called Stannum. This Stannum was fused a second time on a hearth of ashes, and two products were obtained. One, metallic, was Argentum or silver; the other, non-metallic, was called galena or molybdena. This galena, separated and again fused, yielded lead or Plumbum Nigrum. It is quite clear that Pliny here describes the preparation of lead and silver from an argentiferous ore; and we may also learn that Stannum is an alloy of the two metals. It is well known that the ancients did not regard the presence of small quantities of silver in lead, so that the product of the first process, described as good marketable lead, probably contained sufficient silver to repay extraction by modern processes. Although Bedil and Stannum at first only meant this lead and silver alloy, yet very early in our era they became to mean what we now call tin. Pliny tells us that cassiteros was plumbum candidum, that is, white lead. At the time Pliny wrote, this was the name given to tin. It is therefore probable that the Greeks, when tin was first introduced, considered it as only a variety of the older and better known alloy.

From Stannum, the French, Germans, Dutch and English have all borrowed their names for the metal. In old French, tin was Estain; later it was changed to Etain; the German is Zinn (pronounced tsin;) the Dutch is like the English; Stannum itself is said to be derived from the same word as the English stone, but this is very doubtful.

The first tin we hear of is called Tyrian and Keltic. The Tyrians were the importers, and the ancient Britons or Kelts the manufacturers, and hence the names of both were given to the product.

We do not know when tin was first mined in England. It certainly was a marketable product long before the Romans came, but further than this cannot be determined.

The Latin authors tell us that they obtained this metal not only from Britain and the Cassiterides (which were, perhaps, the Sicily Isles), but also from Spain, Portugal, Galatia, and the Hesperides (probably the Canaries.) It is said that tin was worked in Spain before the invasion of the Moors in A. D. 711, but that the works ceased during their occupation. We first hear of the Bohemian tin works in the thirteenth century. Matthew Paris, the English historian and monk (died 1259), tells us that a Cornishman, having committed a murder, fled to Germany. While there, in 1241, he discovered tin, and so laid the foundation of the Saxon mines. This is rather apochryphal, and we are told by another writer that a tin mine has been discovered and worked in Germany in the year 1146. In the thirteenth century so much tin was raised in Germany that it was brought to England and sold so cheaply as to seriously affect the pocket of Richard, Earl of Cornwall.

In the sixteenth century East Indian tin began to attract attention. It was first exported from Malacca, but now chiefly comes from Banca. It is recorded that in 1776 the Chinese were working the Banca mines for the King of Palimbang. The latter gentleman sold the metal to the Dutch East India Company at netting a profit of nearly 200 per cent. Most of the tin produced there went to China and India, but in 1877 the company sent 700,000 lbs. to Europe.

Tin ore has now been found in Cornwall, Ireland, Bohemia, Saxony, Greenland, Sweden, Finland, the East Indies, Australia, Bolivia, the United States and Mexico. It only occurs in quantity at a few of the places, and is still a rare metal.

The latest advices tell us of the discovery, in Mexico, of a tin-bearing district more than twenty miles in extent, having six-hundred veins and eight-hundred drifts of stream tin. It is said that metallic tin can be produced there at one penny per pound. We cannot vouch for the accuracy of these remarkable statements.

Tin has been put to a great variety of uses, and its sphere of usefulness is still extending. Homer and Hesiod tell us it was used for adorning the armor, weapons and dresses of the heroes. The Lapland women in the seventeenth century used to embroider their dresses and fur cloaks with tin wires. In an old book published at Frankfort, in 1673, a picture is given of a Lapland woman drawing the wires. In the fourteenth century the English clergy were forbidden to wear *lunulæ stanneatæ*, crescent-shaped tin ornaments. The spangles that adorn modern ballet dancers are of tin. Without it the coats of our soldiers would lose half their brilliancy, and our red blotting paper would have no existence. For cochineal alone gives but a dull color, and tin, which brightens it, gives it at the same time such permanency that it cannot be economically bleached. Old soldiers' coats, worn and soiled beyond possibility of future use, are therefore converted into pulp for blotting-paper. Imitation gold leaf has been made for at least three hundred years by covering thin plates of tin with a transparent yellow varnish, and the so-called gold paper now sold, is made in the same way.

Aristotle tells us that Dionysius, the tyrant of Syracuse, struck medals or coins (nummi) of tin. Old geographers tell us that before the Portuguese dominion was established in India, large tin coins were in circulation in Sumatra. Tin still forms four per cent. of our bronze coinage.

Cast tin vessels of Roman workmanship, with Roman inscriptions, have been dug up in Cornwall, but these relics of antiquity are very rare. Not a single one was found at Herculaneum, though copper vessels, silvered, were among the treasures. Block tin vessels are used for a variety of chemical operations, and only recently this metal has been, for the first time, drawn into tubes. Vessels of pewter, into which tin largely enters, were so valuable in the time of Henry VIII that they were classed with silver. A regulation enforced in the house of that Sovereign was "Officers of the squillery to see all vessels, as well silver as pewter, be kept and saved from stealing."

At least one of the French churches was roofed with tinned copper* in the sixth century, and this custom has not yet died out. Pliny ascribes the invention of tinning to the Gauls, and especially praises the work of the old inhabitants of Berry. He describes the process by which copper was coated with tin. It is the same still employed for some articles. The cleaned articles were to be immersed in melted tin covered with oil. Pliny says that when finished they looked like silver, and weighed no more than they did before. It has been proved by experiment that half an ounce of tin will cover 254 square inches of surface.

The art of tinning iron was not known till many centuries after. It was discovered in Bohemia. A Catholic clergyman who became a Lutheran, carried the art to Saxony in 1620. The English endeavored to imitate the German plates, but failed, and in 1670 a company sent Andrew Yaaranton to Saxony, to learn the process. This he did, but on his return, and before his company could get a business, some man of distinction managed to learn the secret, obtained the monopoly, and forced them to give up the undertaking which had cost them so dearly.

One of the schemes of the South Sea bubble year (1720) was a manufactory for tin plates, but, unlike its great forerunner and a host of its compeers, it was successful.

Tin plate was made at Pontypool in 1730, and the manufacture was commenced at some earlier period in Monmouthshire, where it still flourishes. The uses of tin plates are, of course, innumerable. The decorated metal introduced within the last few years, has opened a new field for its employment, and even old broken plates and clippings are now largely used for separating copper from solutions containing it. When a piece of tin plate is placed in a solution containing copper, it speedily becomes red, and if allowed to remain long enough, entirely disappears, copper taking its place. Homer tells us that tin was used for making mirrors. An alloy of the metal is used even now for the mirrors of optical instruments, and large quantities of tin foil amalgamated with mercury, are used for the manufacture of all kinds of mirrors and looking-glasses. Tin is now used in the manufacture of phosphor-bronze, and enters into the composition of brass bells, printers' type, Britannia metal, bronze and gun metal. It is an essential ingredient in the celebrated Purple of Cassius, used in glass and porcelain painting, and its use for fixing and improving vegetable colors is still important. Tin filings are a popular vermifuge medicine, and were formerly admitted into the practice of qualified medical men.—*Iron Age.*

*This, with many other facts mentioned here, is taken from Beckman's "History of Inventions."

AMERICAN METHODS IN THE METALLURGY OF ZINC.

The peculiar properties of zinc—its reduction from its compounds at a higher temperature than its point of evaporation and the readiness with which it oxidizes when gaseous—cause its metallurgy to be beset with difficulties unknown in the smelting of other metals. The purity of our ores and the excellence of our refractory materials and fuel, have especially favored American manufacturers of zinc, and it is interesting to note the comments made on American methods by an eminent Belgian metallurgist, M. Jean Beco, who, during his stay in this country at the time of the Centennial Exhibition as a Commissioner from Belgium, made American zinc metallurgy a study, He has published the results of his observations in the *Revue Universelle des Mines*, in a paper which has since been printed in pamphlet form.*

The first American Works which successfully made metallic zinc and zinc white, were those of the New Jersey Zinc Co., in 1850. In 1853, Samuel Wetherill introduced his direct process of manufacturing zinc white at Bethlehem, Pa., but it was not until 1850 that the Liège method of producing zinc was there introduced by Joseph Wharton, and it was at Bethlehem also that the first zinc rolling mill was built, in 1865.

The method universally employed in American Works is the Belgian, and it is by no means gratifying to American metallurgists to hear form an intelligent foreign observer that the state of the art in this country at the present time about corresponds to that attained in Belgium fifteen years ago. M. Beco has seen in this country no evidences of a desire to secure a close and systematic economy, which has been forced upon the Belgian smelters by the decreasing yield of their ores. The abundance and richness of American ores suggested an inquiry into the practicability of exporting them to Belgium, and he believes that such a trade can be built up in the products of some of our Eastern mines.

The consumption of retorts in American works is small, owing to the quality of the refractory clay and the purity of the ores, and it is probable that the use of blast for the combustion of the anthracite fuel, keeps a pressure in the furnace favorable to the yield. The distinctively American direct process of making zinc white, he considers better adapted to some ores than others—for example, it gives especially satisfactory results with such ores as those of Mineral Hill, N. J. The first cost of an American plant is somewhat greater than that for making zinc white by the indirect method of sublimation, notwithstanding the greater simplicity of the former, but the cost of maintenance is less. It is well adapted to low grade pure calamines, if the coal is cheap and possesses the requisite qualities. The product obtained by the indirect method is, it is claimed, purer and has greater covering power. Two works for making zinc white by the American process have been established in Europe, one at Ougree (Belgium) and one at Eysden (Holland).

A point neglected in American practice, which, in the opinion of M. Beco, merits attention, is the calcination of ores at the mines in order to remove carbonic acid—an operation which, being simple, does not need the skilled labor and the careful work which roasting for the removal of sulphur requires. The loss of weight occasioned by calcination would save cost of transportation and permit the utilization of lower grade ores. More careful dressing of the ores would also favorably affect the industry both in the East and West. It would be especially desirable for ores which are a mixture of minerals requiring different modes of treatment Such, for instance, are the ores of Mineral Hill, N. J., which, in their natural state, are especially fit for the manufacture of zinc white; but as the slow development of the consumption of that product seriously restricts the utilization of the ore, dressing would separate from the mixture zinciferous mineral suitable for the manufacture of spelter. The dressing cannot be carried beyond a certain limit on account of the slight differences of density, but the mineral would become more uniform and the modes of treatment would be simplified.—*Metall. Review*, i, 326.

* De l'Etat Actuel des Industries du Zinc et du Cuivre aux Etats-Unis d'Amerique, par Jean Beco, I. C.

PROGRESS IN SCIENCE AND THE ARTS.

☞ *This department is designed to give our readers a weekly summary of scientific and technical news. To add to its value, the reproductions, abstracts and translations from home and foreign journals, are in every case credited to their proper source, volume and page. As they are obliged to assume the responsibility for the accuracy of translations, the Editors request of their contemporaries the courtesy of an acknowledgment when such translations are copied.*

CHEMISTRY, PHYSICS AND TECHNOLOGY.

Something New About Oxygen.—Recent investigations have disclosed the singular fact, that oxygen under high pressure rapidly destroys all living beings and organic compounds. All the varied phenomena of fermentation, in which the chemical action depends upon the presence of living organisms, are completely arrested by the action of compressed oxygen, even if exerted for only a brief time; while fermentations due to dissolved matter, like diastase, perfectly resist its influence. M. Bert, to whom this curious discovery is due, has found a practical application of it in the field of physiological research. The ripening of fruits is arrested by exposure to compressed oxygen, and hence it must arise from cellular evolution. The poison of the scorpion, on the other hand, whether liquid or re-dissolved in water, entirely resists the action of the compressed gas. Such poisons evidently owe their power to chemical compounds akin to the vegetable alkaloids. Fresh vaccine matter, subjected for more than a week to oxygen under a pressure equal to fifty atmospheres, retained its virtue, from which it would appear that the active principle in vaccine matter is not certain living organisms or cells, as some have supposed. The virus of glanders, after similar treatment, quickly infected horses inoculated with it; and carbuncular blood, though freed from bacteria, was found to retain its dangerous properties after the same test. These must, therefore, be put in the same class with vaccine matter.

If these results are confirmed by further investigations, the discovery is certainly a most important one. and will lead to the settlement of many disputed questions in physiological chemistry.—*Journal of Chemistry.*

Objections to the Metric System.—Some time ago the House of Representatives passed a resolution calling upon the heads of Departments to report what objections, if any, there are to making obligatory, in all Government transactions, the metrical system of weights and measures, the use of which has been authorized by Act of Congress. Two replies have been received. That from the Postmaster-General says the only objections to making the system obligatory throughout the postal service are two, one based on the expense incident to the change of systems, and the other based on an apprehension that the practical workings of a new system will fail to give satisfaction, owing to the lack of knowledge and experience by a great many postmasters, especially at the small post-offices, and by the public at large. The Postmaster-General says if Congress should decide to use the metric system in the postal service that an adequate appropriation should be made to supply all the post-offices with suitable scales and balances, and that, after the supply shall have been completed, a certain time, say six months, shall be allowed before requiring their obligatory use. Twelve months would be ample time to supply the offices, and eighteen months after such apppopriation is available, the new system could go into operation. The Secretary of the Navy says: "If it were desired to make the metrical system of weights and measures obligatory in all Government transactions, the Navy Department perceives no objection to it, except in so far as regards the soundings given on charts. If it were applied to these it would probably involve a total loss of all charts and chart-plates now in use, and be prejudical to the exchange of charts with England.

Magnetic Property of Hydrogenium.—It is known that palladium is feebly magnetic, and that hydrogen is feebly diamagentic, and when the late Professor Graham succeeded in "occluding" hydrogen and palladium, he believed that the resulting alloy would be at least less magnetic than before, but to his surprise he found it much more magnetic. M. Blondlot has inquired into the anomaly, and found results in all cases opposed to those of Graham. He finds that palladium charged with hydrogen is much less magnetic than when in the pure state. It is thought that Graham's materials have been impure.—*Tel. Journal*, v, 279.

The Scheme for Telegraphing Without Wires by means of ærial currents of electricity, has been revised by Professor Loomis. He has met with success in using kites for this purpose, a copper wire being substituted for the usual kite string. Signals were transmitted thus between kites ten miles apart. His new experiments are made in the mountainous regions of West Virginia, between lofty peaks. Continuous ærial currents are found at these altitudes, which will serve the purposes of the telegraph, except when rarely interrupted by violent disturbances of the atmosphere. A scheme is now on foot to test the merits of ærial telegraphy in the Alps. The cheapness of the apparatus, as no wire is required between the stations, is greatly in favor of the method, and may counterbalance its liability to occasional interruption.—*N. Y. Tribune.*

Heat and Force Produced by the Explosion of Nitro-Glycerine.—The temperature developed by the explosion of nitro-glycerine, has not as yet been determined with accuracy; but as the combustion in the case of gun powder is nearly perfect, the elevation of temperature produced by the explosion of the former is certainly much greater than that of the latter, perhaps more than twice as great.

A volume of gun powder produces, at the ordinary temperature, 190 volumes of gas. Owing to the heat produced, this gas occupies about four times the above mentioned volume, or about 760 volumes of gas are produced immediately after the explosion. A volume of nitro-glycerine produces 1,300 volumes of gas at the ordinary temperature, and admitting that the heat produced by the explosion is two and one-half times that produced by gun powder, this volume would be increased to 13,000 volumes. The force of nitro-glycerine is nearly thirteen times as great as that of gun powder, but on account of the energy of the combustion, the action is still further increased. —*Revue Industrielle*, viii, 458.

Carbolic Acid on Metal Cutting Tools.—The *Papier Zeitung* mentions that a Herr J. Asby strongly recommends the use of carbolic acid for moistening the tools with which metals are worked. The duty of the grindstone is even said to be increased by the use of the acid. The dark and impure acid can be used for this purpose.

ENGINEERING—CIVIL AND MECHANICAL.

Novelty in Car Construction.—Mr. George Richards, the master mechanic of the Boston and Providence Railroad, has recently built two gondola cars, in which old steel rails are used for longitudinal sills. He also contemplates building a flat car for carrying lumber, and a merchandise box car upon the same plan. Four 30-feet rails, weighing 57 pounds to the yard, are used in each of the two cars already built. They are placed tops down, with strips of plank bolted to their flanges as a foundation for the floor. The bolts are three feet apart, and the floor planks are spiked to the strips in the usual way. The transom timbers are bolted to pieces of iron riveted to the web of the rails and bent around underneath their reversed tops, so as to secure a complete bearing from floor to transom. The end-sills are of oak, in which recesses are made with pocket castings inserted in them for the reception of the rail ends. These are held to the sills by forked bolts riveted to the web of the rails, and passing through the sills and castings. There are four longitudinal truss-rods $1\frac{1}{6}$ inch in diameter. The drawing attachments are put in as easily and as cheaply as in a wooden floor frame, and the entire construction is quite simple and free from difficulty.

One of the completed cars weighs 17,270 pounds, and the other 18,750 pounds, with sidings, and they have carried 34,630 and 43,550 pounds of coal respectively. Their length over end-sills is 30 feet 11 inches.

This kind of construction, although an experiment thus far, has an important bearing upon the problem as to what extent iron or steel can be advantageously substituted for wood where the elements of strength and stiffness are the most needed. It is claimed by some that timber sills will resist severe end or side collisions better than iron; but whether this be so or not, the capacity of steel rail sills, combined with suitable trussing, must be very great for sustaining a load. And in this case, there is obviously a stroke of economy in utilizing old rails by taking them from the track and turning them into ready-made car sills, with no expense in the way of cutting, forging, or shaping.—*Railway World*, iii, 1117.

Another Improvement Project.—It is well known that the main stream of the Nile is supplied by the great equatorial lakes of Africa, and that the annual inundations are caused by the inrush of torrent water laden with soil from the fertile slopes of the Abyssinian plateau in July, August and September. This silt is now for the most part being deposited in the bed of the Mediterranean, where it is gradually forming a new delta similar to the delta already formed at the river's mouth. Sir Samuel Baker has written to the *Times* suggesting a plan by which not only the water of the Nile but the mud which it now deposits wastefully in the sea may be turned to good account as a fertilizer of the deserts of Nubia, Libya, and the Soudan. He proposes by suitable engineering works to divert a portion of the Nile flood-water into these deserts, where it can deposit its rich sediment on the sands, and also irrigate them so as to transform them from a desert into "cotton-fields that would render England independent of America." This could be effected by having suitable dams and sluices at different points of the Nile, say at the Cataracts. These dams and sluices, by enabling craft to pass the Cataracts, would also render the Nile navigable from the Mediterranean to Gondokoro, a space of 29 deg. of latitude.—*Telegraph Journal*, v, 283.

A Great Work in Holland.—The latest and in some respects the most important of the many remarkable engineering works of Holland, says the *Railway World*, is the new railway bridge over the Maas at Rotterdam. This work, after an expenditure of nearly 2,000,000 florins, of which rather more than half has been expended on the superstructure, and less than half for the substructure, has been completed within eight years, about the same time required for the construction of a similar bridge at Hamburg, and that between Venice and the Continent. Five gigantic wrought iron arched girders, resting on immense piers, and of spans, ranging from 216 feet 6 inches to 295 feet 4 inches, and a heighth of nearly 20 feet above ordinary high water level, connect the city with an island in the middle of the stream, two other arches uniting this island with the opposite shore. Another great work at Rotterdam is now in course of completion, which has attracted general attention on the Continent. A few paces below the railway bridge, another bridge the so-called "Wilemsbrug," to serve for the ordinary carriage traffic of the city and foot passengers, is in course of construction. The foundation stone of this bridge was laid three years ago by the King of Holland in person. This, like the railway bridge, is provided with two pivot arrangements, of which one is within the city, the other in the canal called the King's Harbor (Koning's Haven), 656 feet wide, between the opposite shore and the island above mentioned, to permit the passage of the largest ships.—*Mining & Scientific Press*, xxxv, 294.

Transmitting Power Long Distances.—Prof. Osborne Reynolds, delivered a long and valuable address before the Manchester Scientific and Mechanical Society, on the transmission of power long distances. He analyzed all the means proposed, carefully, and arrived at the following conclusions. Twenty miles appears to be the outside limit to which power may be economically transmitted, even when the power can be had for nothing, and the most enonomical means of doing this, is probably the wire rope. This review, therefore, shows the hopelessness of our ever utilizing the natural sources of power, such as tidal rivers for mechanical purposes, unless we conduct them on the banks of those rivers. But as regards the substitution of a general source of power for the small steam engines now in use in our towns, the case appears more hopeful; and, what is more, this has already been done in some instances. In the most notable instance, that of Schaffhausen, the power is obtained from the Rhine, at a point close to the town, and is conveyed along the banks of the river, which crosses the ends of the streets of the town, by a wire rope, which, as it passes the ends of the streets, gives motion to shafts which are laid in a channel under the pavement, and from which the power can at once be introduced into the various manufactories. In our own country, also, in the town of Hull, I believe that pipes have been laid down to convey the power derived from steam in the form of water, under a pressure of 600 pounds, over some part of the town. It does not appear unreasonable, therefore, to suppose that something of the same sort might be done in our own city. Considering that a very large proportion of the power required in our warehouses is for hydraulic presses, it would appear desirable that, in part at least, the power should be communicated to water pressure. Where rotatory motion is required, the machinery might be driven by pressure engines, but as this would entail considerable waste, and as power may be more cheaply conveyed by compressed air, it might be better to supply both water and air; as regards the mechanical means, ropes and shafts. Although the former appears on the whole to be the most economical means of communicating work, and to a certain extent, their superiority is supported by the instance of Schaffhausen, considering their inconvenience in a town, I think that the pipes would be preferable. With the ability to have either water or air at the most convenient pressure, and at a reasonable cost, I think that but few users of power on any but the largest scale, would care for the trouble, danger, dirt and expense of having steam engines of their own; and if this be so, there would then be a chance of reducing the impurities in the air. Looking at these facts, I cannot help thinking that there is open to the engineer a field of enterprise, in which he may not only find remunerative employment for his talents, but in so doing confer a great benefit on his fellow creatures. This may not be so. The scheme, when closely considered, may be found wanting, but it will have served my principal purpose if it has helped to illustrate and render interesting what would have been otherwise desultory remarks about the transmission of work.—*M. & S. Press*, xxxv.

A Diamond Drill is to be started on the 1,600-foot level of the California mine. The object is to find out what lies to the eastward. The east clay wall has never been found anywhere beyond a point 200 feet north of the south line. The

diamond drill is to be sent in search of it. No drift has ever been run into this portion, for the reason that it was feared a flood of water would be let in that would drown the lower levels of the Ophir, and all else in that vicinity. By using the drill, the region in question may be prospected, and a rush of water guarded against, as should there be a flow sufficient to give trouble the drill hole may be plugged up. The place in which this prospecting is to be done, lies in the direction in which the recent development was made in the Ophir, but 500 feet above the new Ophir body.—*M. & S. Press.*

A Costly Railroad.—A costly railroad will be the extension of the Metropolitan District line in London—a section one mile and sixteen rods long, known as the "inner circle completion," as it will connect the Metropolitan and Metropolitan District roads (both underground lines) at their eastern ends, and make it possible to run trains entirely around the ellipse formed by the two roads, which at present are connected only at their western ends. This link is estimated to cost £2,100,000, or at the rate of about $10,000,000 per mile. The city will, however, allow $2,500,000 for a new street which has to be constructed in connection with the work, and which has to be done by August 7th, 1879. Costly as this work is, says the *Iron Age*, we have something quite comparable to it, in expense, in this country in the great St. Louis Bridge, which, however, has but the merest fraction of the tariff which supports the London underground roads. This single mile of road will cost more than the entire system of elevated roads proposed for New York.—*Mining & Scientific Press*,

The Annual Statement of the Condition of railroads in Great Britain for 1876 affords some interesting points of comparison with roads of the United States. There are only 16,872 miles of railway in Great Britain, the addition for 1876 having been 214 miles. The number of miles of road in the United States is 77,000—more than four times the number of miles in Great Britain. In the latter country there is one mile of road to every 2,000 persons. In this country there is one mile of road to every 533 persons. The first reflection suggested by this is that Great Britain is very insufficiently supplied, and the United States very well supplied with railways. But there are other facts in the comparison which show that Great Britain possesses about all the railways it needs, while we possess more than can be run at a profit, and therefore, more than we really need. The total nominal capital of the 16,872 miles of British railways, including stocks and loans, is $3,290,000,000, while the total nominal capital of our 77,000 miles is about $4,500,000,000. The capital of British railways represents an average cost of about $190,000 per mile, while that of our railways represents an average cost of about $53,000 per mile. The gross earnings of the British roads for 1876 were $310,000,000, or $18,440 per mile, and their net earnings $142,000,000, or $8,666 per mile; the gross earnings on our roads were $497,000,000, or about $6,600 per mile, and their net earnings $186,000,000, or $2,415 per mile. Our 77,000 miles of road earned more than a half more, gross, than the 16,872 miles of British, but the net earnings of the British roads were nearly four times as great to the mile as ours. The percentage of operating expenses in Great Britain is 54 per cent. of the gross earnings; in the United States it is 69 per cent.—*Engineering News*, iv, 325.

MINING, METALLURGY AND MINERALOGY.

Our Iron Industry.—The following figures will give some idea of the extent of the iron manufacturing interest of this country. As near as can be determined from the data at hand, there are in this country about one million (951,000) operatives employed in the production of iron. Of these, 45,000 are employed in the preparation of the ore, and fuel; 27,000 are employed in preparing fuel for the rolling mills; 25,000 are employed in blast furnaces, and 4,000 in the bloomeries; 849,000 are engaged in manufacturing articles of iron, making the grand aggregate 951,000 men employed in the iron interest. A large proportion of the 849,000 engaged in manufacturing articles are skilled workmen. Giving the usual proportion of minors and females dependent upon the workers, and we have about 5,000,000 people, nearly one-eight of the population of the country, directly and indirectly belonging to the iron industries. The value of pig iron manufactured last year was $75,000,000. The production of the rolling-mills and forges was $63,000,000, and the entire value of other manufactures of iron, $762,000,000. The entire value of manufactured iron for the year was $900,000,000.—*W. Manufacturer*, iv, 600.

The Manganesious Ores found at the McComber mine, says the Marquette *Mining Journal*, of which 4,000 to 5000 tons will have been shipped at the close of the season, brings an advance of $1.25 per ton over the other hematites, and is much sought after by furnace men. It is believed that 10,000 tons of this ore can be mined next year.

Manganese Mines near Cave Spring, La., are being worked with fair success. The company have their mines in full blast, and about sixteen tons per day of twenty-four hours, are being extracted. The ore yields 76 per cent. peroxide of manganese.

Whitwell's New Hot Blast Stoves.—The chief peculiarity which distinguishes the new form of stove from that used prior to 1876, is its greatly increased height. The advantage of this form of construction is a decrease in cost per square foot of heating surface. In making a new stove of double the capacity of the old one of the same diameter, the only increase in cost is that of the plain brick walls and sheet iron casing, which are merely increased in height. Water-cooled slide valves are used instead of the old form of conical seat valves, the advantage being cheaper first cost, and equal convenience and freedom from liability to get out of order.

The following are the sizes and area of heating surfaces which are now constructed:

Heating surface.		Heating surface.	
15×50 feet.	7,172 sq. feet.	15×60 feet	8,647 sq. feet
18×50 "	11,138 "	18×60 "	13,528 "
22×50 "	16,703 "	22×60 "	20,287 "

Mr. Whitwell's rules for adapting these sizes to any blast furnace is as follows:

One ton in the furnace per week demands 65 square feet of heating surface in stoves. Example: Furnace to make 200 tons per week, requires 200×65=13,000 square feet of heating surface. This requirement is met by two stoves 15×50 feet. Two stoves, it is claimed, will work a furnace, but three are better.

A great mistake has been made in some furnaces which have erected Whitwell stoves having too small a heating surface. The required temperature of blast cannot be obtained unless the heating surface is proportioned to the quantity of air blown into the furnace, or to the product of iron, as in the above rule. If a surplus heat is required for emergencies, the surface heat should be even greater than that indicated by the rule.

Mr. Whitwell stated recently that 416 of his patent stoves are now either in use or in course of erection in various parts of the world. We are informed by the agents that the cost of these stoves has been reduced in this country about 60 per cent. below their cost in 1876.—*Am. Manufacturer.*

MISCELLANEOUS.

The Flora of the United States.—Dr. J. D. Hooker, since his return to England, has written to *Nature*, speaking with satisfaction of the hospitality he met with in his western trip, and mentioning that the railway authorities carried the party across the United States and on the branch lines traversed, without charge. As the net result of the observations on American vegetation, he states that the middle latitudes of our Continent have three principal meridional floras, incomparably more diverse than those of similar meridians in the Old World, and as to trees, shrubs, and many genera of herbaceous plants, absolutely distinct. The three main divisions are two humid, and one, intermediate, dry. The subdivisions of each of these areas are three apiece, as follows: (1) The Atlantic Slope with the Mississippi Valley consists of (a) an Atlantic, (b) a Mississippi Valley, and (c) an interposed mountain region with temperate and sub-alpine flora. (2) The Pacific Slope includes (a) a humid, cool, forest-clad coast range; (b) a hot and drier valley with the San Juan and Sacramento rivers; (c) the Sierra Nevada flora, temperate, sub-alpine and alpine. (3) The Rocky Mountain region (from the Mississippi beyond the forest region, to the Sierra Nevada) has (a) a prairie flora; (b) a desert, or saline flora, and (c) a Rocky Mountain proper flora, temperate, sub alpine and alpine. Not a pine, oak, maple, elm, plane or birch of Eastern America extends to Western; and genera of thirty to fifty species are confined to each. The Rocky Mountain region, though distict from either side, contains a few elements from each—mostly from the Western flora.

Stimulating Progress Among Young Mechanics.—Honorable competition in actual work is a great incitement to progress. This we think is well applied by an English society of turners. The subjects of competition were turning in ivory, pottery, stone and jet; and steel, brass and gold for horological purposes. The competition in ivory included vegetable ivory. The qualities considered in awarding the prizes were: Beauty of design, symmetry of shape, utility, and general excellence of workmanship; exact copying, so that two objects produced should be fac similes in every part, or exact measures of capacity; fitness of the work or design for the purpose proposed; ability to turn, whether circular or oval; and novelty in application of turning or in design. Carving was admissible, but it was to be subsidiary to the turning. The candidate was to make his own selection from the above conditions; but the one who best fulfilled the largest number, including the most important qualities, was preferred. The work to be all hand-turning, produced in the lathe without special rest or tool apparatus, and the carving to be the work of the exhibitor.—*Mining and Scientific Press*, xxxv, 323.

A Mail Bag Catch, for taking mail bags and delivering them from a car while the latter is in motion, has been patented by George F. Shaver, of Westfield, N. Y. A rod on the car seizes a bag suspended from the roadside crane, while another rod on the latter, at the same time, takes a bag suspended from a frame attached to the car. The bag entering car slides inward and strikes a curtain, so that it is subjected to no injurious shock.—*C. R. Rev.*

Cotton Belting.—The *Textile Manufacturer*, England, says Mr. Aitkin, of Helmshore, near Manchester, has taken out patents for cotton belting. The belts themselves are woven in a peculiar manner from doubled yarns, and may be made of any length and size from forty-eight inches wide and one-half inch thick. After being woven they are saturated with water and stretched, and, while still extended, they are dried; in fact the moisture is driven off by a drying cylinder in the process of stretching. The belts are now passed through a heated liquid preparation, somewhat resinous in its nature, with the object of giving them a degree of solidity, and the excess of the mixture is removed by passing the belts between rollers, after which they are again allowed to dry. If required, for the sake of appearance, they may now be painted, but this is not recommended by the inventor. The belts, when put to work, do not stretch, practically, at all, the first belt made, over sixty feet long, doing good work for over two years before requiring to be taken up. There is not the slightest tendency to fray on the edges. They run with remarkable truth, having but one joint, and do very heavy work, a 3½ inch belt driving two throstle frames, with 420 spindles. The joint in the belt is made in the ordinary way, by punching and lacing the two ends together. It is claimed that this cotton belting will do the work that any other kind will, and that it acts satisfactorily where some belts will fail, while, on the score of economy, it is the cheapest made.

"Tunneling, Explosive Compounds, and Rock Drills."—Giving the details of practical tunnel work, the constituents and properties of modern explosive compounds, the principles of blasting, the history of the rise of machine rock-drilling, and detailed descriptions of the various rock-drills and air-compressors in use. Also, descriptions of the European and American systems of timbering and arching, and tables giving the dimensions and cost of over seventeen hundred tunnels, from notes furnished by engineers and railroad companies in Europe, North and South America, and New Zealand; with, also, a history of tunneling during the thirty-four centuries succeeding the reign of Rameses II. By Henry S. Drinker, E. M., graduate of the School of Mines, Lehigh University, member of American Institute of Mining Engineers. Illustrated with about one thousand cuts set in the text, and several large folding plates, comprising geological and working profiles of the Nesquehoning, the Musconetcong, and the Hoosac tunnels, etc.

Messrs. John Wiley & Sons, 15 Astor Place, New York, announce that they have in press, and will publish early in 1878, the important work described above. Mr. Drinker has been engaged for several years in its preparation, and the value of his arduous labors as a student of the subjects described in the title, was enhanced by extensive practical experience gained in the construction of the Musconetcong tunnel, and a recognition of the difficulty hitherto experienced in obtaining, in an accessible form, satisfactory accounts of the modern progress in tunneling. Such information will render exceedingly useful aid to railway companies, or to parties engaged in the construction of new railways, and the extent to which it is furnished may be judged from the statement that some seventeen hundred tunnels are treated, and materials for the work drawn from every part of the world. Advance sheets of the work have elicited high encomiums from a number of distinguished engineers and railway officials, and it will evidently have irresistible claims upon the patronage of all classes interested in the topics discussed.

The German Universities.—The German university system is so well and favorably known, that a large number of students travel thousands of miles to enjoy its advantages. These universities offer to foreigners special facilities denied to youth of German birth; and in the matter of entering-conditions this is particularly notable. A native must have pursued a suitable course of preparatory study, which includes six years in the gymnasium. A foreigner who brings the passport of his own country is at once admitted, and no further questions asked. He may or may not understand the lectures he engages to attend; he may attend one course or six; he pays only for the advantages he enjoys, and may usually enjoy these privileges for several weeks before paying anything. On passing a satisfactory examination, he receives the degree of Ph. D. The lectures of the German professors are always open to the public, and the tourist or business man, as well as the scholar, can, while in Berlin, listen to the eloquence of such men as Hofmann, Kirchhoff, and Dubois Raymond; at Heidelberg, to Bunsen; at Leipsic, to Kolbe; and at Bonn to Kekule. He is not stared at, no questions are asked, and his presence is scarcely noticed.

One of the German universities, founded about seventy years ago, now stands at the head of the list—the Frederick William University, at Berlin. The number of matriculated students last summer was 2237. In winter the number is usually greater. Last winter there were 2490. Of the former number 1862 were Prussians, 39 were from America, 6 from Asia, 4 from Africa, and 2 from Australia. The number of professors is 130, with 81 other instructors. In addition to the matriculated students there are 2074 members of othe

institutions entitled to attend the lectures, making a grand total of 4311.

Leipsic stands next to Berlin in point of numbers. This university was founded in 1409, being just four centuries older than that at Berlin. It has 118 professors and 40 other instructors, with 2842 matriculated students. Both Leipsic and Berlin enjoy the advantages of excellent chemical laboratories, with special facilities for organic research.

Munich, the capital of Bavaria, has an excellent university, which draws to it 1267 matriculated students. Since the death of the great Liebig, Prof. A. Vogel has filled the chair of Agricultural Chemistry here, but the university is less sought by scientific men than either of the above mentioned.

Several of the smaller universities are celebrated as offering advantages of pursuing some particular branch of study. Thus, Heidelberg has a great attraction for the student of inorganic chemistry, from the world-wide reputation of Geheimrath Bunsen, a name familiar to every student of chemisty the world over. But Heidelberg has met with an irreparable loss in Bunsen's colleague and co-inventor of the spectroscope, Professor Kirchhoff, now in Berlin. In the resignation of Blum, the mineralogist, too, it had a blow little inferior to the loss Berlin met with in the death of Gustav Rose. The Ruprecht-Carl University, in Heidelberg, was founded in 1386. It has 64 professors and 46 other instructors, with only 766 matriculated students, and 68 other listeners entitled to attend. There is no garrison here, and the students cannot serve in the army while attending lectures, as in Berlin, Leipsic, and other garrison towns.

Bonn, on the Rhine, has a university dating from 1818. It numbers 82 professors, among them the celebrated chemist Kekule. Here, too, organic chemistry has special facilities offered for its prosecution, and many foreigners resort hither. The number of matriculated students is 897.

Gottingen is less sought by chemical students than at the time when Wohler led in the investigations of inorganic substances. There are here 88 professors and 917 students.

The Vienna University, founded in 1365, is probably the largest in the world. It has 131 professors and 114 other teachers, making a total of 245 instructors, with 3152 matriculated students. It is much frequented by students of medicine, divinity, etc. Tschermak, the celebrated mineralogist, is here.

The University of Prague, founded in 1347, is not particularly celebrated beyond the limits of Bohemia.—E. J. H., *Boston Jour. of Chemistry*, xii, 69.

About Broken Bottles.—What becomes of all the broken bottles? may well be asked. Thousands of tons of bottles are broken every year in London alone, and the difference between the sound and the broken bottle must be something very considerable. Broken "wines" and broken "sodas" are converted to many useful purposes, the latter especially. The best soda-water bottles come from Yorkshire, and the "gingers" from Derbyshire. The sodas are no longer sent to the metropolis packed in crates, as formerly. In the crate they were pilfered to a very great extent *en route* to their destination, and the cost of carriage was higher. They are now transmitted in bags made of coarse canvas, and packed in layers of straw. Each bag holds eight dozen. The broken bottles are subsequently utilized for manufacture of cheap jewelry, chimney ornaments, and inferior household glass for the manufacturing districts. They are also used for the manufacture of emery powder, glass paper, etc. Some idea of the number of "sodas" broken in the processes of filling, corking, cleaning, and distributing, may be gathered from the circumstance that one of the London mineral water manufacturers sold last year 100 tons. The value of the "metal," as it is styled, is somewhere about 10s. per ton, but it varies according to the demand.—*British Trade Journal.*

A New Car Brake, devised by Jacob J. Anthony, of Sharon Springs, N. Y., comprises a cylinder containing pistons, which are forced apart by steam, water, or air, under pressure. By this means levers are moved so as to force the brake shoes against all the wheels simultaneously, and with an equal pressure on both sides of each wheel.—*C. R. Rev.*

Adulteration of Milk.—Our contemporary the *Deutsch. Ind. Ztg.*, remarks that the native milkmen are falsifying their milk by the addition of chalk and water. Also, that infusorial earth has been detected in milk purchased in Hamburg.

Discovery of Oil in West Virginia.—Oil has been discovered in Kanawha Valley, West Virginia, 3¼ miles from Charleston.

—Minnesota is entitled to be called the Lake State. From recent statistics it appears that in the actually surveyed portions of the State there are just 4,999 lakes. Calling them 5,000 in number, and from reliable data they average 300 acres each, this gives us an equivalent of 1,500,000 acres of water in the surveyed portions of the State.

—The Singer Sewing Machine Company have lately opened an office at Rome, Italy, and in Switzerland, and sub-offices in many of the towns in both countries.

The Average Locomotive Mileage per Year in the different countries of the world has been calculated by Prof. Stuermer, of Bromburg, and for the leading countries the figures are as follows: France (1873), 23.475 miles; United States (1875), 21,900; Great Britain (1875), 16,865; Germany (1875), 11,834; Austria (1875). 11,700; all Europe (1875), 15,300; East Indies, 13.400. From the same source we learn that the average number of trains per day both ways in 1875 was 20.9 in Europe, 14.7 in the United States, and 8.2 in India. —*Railroad Gazette*, ix, 521.

Record of New Railroad Construction.—The *Railroad Gazette*, for Nov. 23d, contains information of the laying of track on new railroads as follows:

Brown Lumber Company.—Track laid from Whitefield, N. H., east to Jefferson Meadows, 12 miles.

Ligonier Valley.—Completed from Latrobe, Pa., southeast to Ligonier, 10 miles It is of 3 ft. gauge.

Columbus and Hocking Valley.—The *Monday Creek Branch* is completed from Nelsonville, O., east to the mouth of Snow Fork, 3 miles.

This is a total of 25 miles of new railroad, making 1,892 miles completed in the United States in 1877, against 1.970 miles reported for the corresponding period in 1876, 1,150 in 1875, 1,664 in 1874, 3,276 in 1873, and 6,202 in 1872.

The *Railroad Gazette*, for Nov. 30th, contains information of the laying of track on new railroads as follows:

Foxburg, St. Petersburg and Clarion.—Extended from St. Petersburg, Pa., eastward to Turkey City, 5 miles. It is of 3 ft gauge.

Union Railway, Transferand Stock Yards.—This company's road, generally called the *Indianapolis Belt*, is extended from Brightwood, Ind., west to North Indianapolis, 4 miles.

Maple River.—Extended from Ida, Ia., southeast to Mapleton, 24 miles.

Central Branch, Union Pacific.—Extended from GreenLeaf, Kan., west by south to Clifton, 20 miles.

This is a total of 53 miles of new railroad, making 1,945 miles completed in the United States in 1877, against 2,102 miles reported for the corresponding period in 1876, 1,150 in 1875, 1,686 in 1874, 3,355 in 1873, and 6,311 in 1872.

—A prismoidal one-rail railway is in course of construction in the Bradford oil district.

—The power of a horse is said to vary from five to eleven times that of a man... A new item of commerce—coffins—from Norway.....Copper is believed to exist in the human blood... Portable iron huts are in use by the Russian army; they use condensed forage.....The Hayden Geographical Survey parties are preparing their reports of last season's expeditions.....The Patent Bar Association of Washington has proposed amendments to the Patent Laws.....Why is this thus? near-sightedness increases in proportion as civilization advances..A number of the street lamps of Providence, R. I., are lighted and extinguished by electricity.....The souring of milk during a thunderstorm is explained to be produced by the conversion of oxygen into ozone.....The next transit of Mercury will be observed at San Francisco, by a French expedition, on May, 6, 1878.....Printing with types of hardened glass has been worked successfully.....The faucet has been improved, avoiding leakage by carelessness or accident.....Some one has estimated that 400 millions shooting stars are daily burned up in our atmosphere .....It has been found that scorpions sing.... American petroleum is distributed to all parts of the world as the cheapest illuminator.....The lamented Agassiz, located the oldest part of the world at the Trenton Falls, New York..... It would take four million years to distribute meteoric dust over the earth's surface in a layer as thick as this paper..... The draft of a treaty has been submitted to the U. S. Senate for the reciprocal protection to trade-marks in United States and Great Britain.....Attention is being called to the serious dangers caused by the refuse of galvanizers in the pollution of streams—sewers, it is noticed, have been greatly injured..... Arrangements are about to be consummated to open direct mail communication with Brazil; the government of that country has offered a subsidy for that purpose..... A Royal Society Medal has been awarded to Prof. James D. Dana for his services to science for half a century...Nature has given the portrait of another "Scientific Worthy"—Sir Joseph D. Hooker, with an interesting biographical sketch by his friend, Dr. Gray, of New Haven.....The navies of Spain, Portugal and Holland, have agreed to co-operate with the Signal Bureau of this country.....The corrected distances of the planets from the sun are given as follows: Mercury, 35,392,000; Venus, 66,134,000; Earth, 93,321,000; Mars, 139,311,000; Jupiter, 475,692,000; Saturn, 872,137,000; Uranus, 1,753,869,000; Neptune, 2,745,998,000.....The "Horseshoe" at Niagara is now a right-angle, rather than a curve. The rocks in the centre have been eaten away from year to year, and now the side walls are crumbling.....It is a source of annoyance to be unable to see the numbers of many houses at night-time. This is remedied in Paris by using a lantern of colored glass with the number in white.

MANUFACTURING AND INDUSTRIAL NOTES.

—A Pittsburg paper says that the Pennsylvania Railroad shops, upper and lower, at Altoona, employ three thousand operators. With the facilities at hand an eight-wheeled copper-bottom car can be constructed in an hour, and recently one hundred and twelve of this class were turned out in a week, of ten hours a day. An eight-wheeled box car can be made in nine hours, including one coat of paint, and a passenger car be built in two days. So far during the year, 5 passenger, 5 postal and 1,771 freight cars have been constructed, and 350 passenger and 9,373 freight cars repaired. The wages of the employees aggregate about $1,500,000 annually.

—The Johnstown *Tribune* furnishes some interesting historical information. The first foundry in Pittsburg was erected in 1803, on the site now occupied by the post office. Its products at first were pots, kettles and other domestic utensils, but in a few years it was called upon to make cannon balls for the government, and in 1811-12 the first cannon made west of the Alleghany Mountains was cast at this foundry, the establishment being thereafter kept busy furnishing cannon and shot until the close of the war in 1814. The first water-pipe and the first rolls were also made at this foundry; and it was in this pioneer establishment that James Harley, a moulder, discovered the method of making chill rolls.

—Product of Pennsylvania Steel Company, for the month of November, 1877: Tons of steel made 7,196 tons, tons of ingots bloomed 8,190, tons of finished rails produced 6,915. The largest days work (two turns) in Converting Department 359 tons, largest tonnage of ingots bloomed in one day, 441 tons, largest product of Rail Mill in one day, 354 tons. The above work was accomplished by the regular working force of the mills. The Converting Department working eleven turns per week, each turn twelve hours. The Blooming Mill and Rail Mill, each working eleven turns per week, each turn eleven hours. The average weight of rails during the month was 62lb per yard, the Rail Mill making seven changes of rolls during the month. The shipments of rails during the month were 7,237 tons.

—The South Bridge Co., of Toledo, have been awarded the contract for building a Howe truss highway bridge over the Little Miami River, at Miamiville, Ohio.

—The Cleveland Cast Steel Co., is the title of a new company recently organized in South Cleveland, O., for the manufacture of steel castings of all kinds, crucible steel and spring steel, also tool and machinery steel.

—The Phœnix Glass Works of La Salle, Wis., which have been closed since August last, it is said, will soon resume operations. A new company has purchased a controlling interest in the works, and will soon commence work. Many of the old and best employees who were forced to seek employment elsewhere will probably be re-engaged.

—The total of Bessemer steel ingots made at the Cambria Iron Works, for the fiscal year ending October 31, 1877, was 75,127 tons.

—The works of the United States Iron and Tin Plate Company have alone been running full double turn, and are still supplied with abundant orders. The United States terne plates are gaining reputation all over the country, and the company is almost unable to supply the demand.—*Am. Manuf.*

—A new nitro-glycerine factory is about to commence operations at Titusville.

—The Bradley Manufacturing Co., Syracuse, N. Y., have recently shipped two of their cushioned helve hammers to Sheffield, England, and have orders in hand for five more, showing an increased demand for "Yankee" inventions. Besides this, they have, during the last thirty days, shipped fifteen of these hammers to different parts of this country.—*Am Manuf.*

—The shipments of paper for postal cards from the Parsons Mill at Holyoke, last month, averaged 16 cases of 400 pounds each daily, or a total of nearly 100 tons for the month.

—It is anticipated that Sharp's Rifle Company of Bridgeport has a very favorable prospect of securing from the Chinese government a contract for one million of their new military rifles. Samples of the rifles manufactured by several American companies have been sent to China for trial, and it is said that the government agent of China who visited this country on this special business, recommends the Sharps above all competitors.

—The Kellogg Bridge Co., of Buffalo, N. Y., were awarded the contract for the Maumee River bridge at Toledo, Ohio, for the Lake Shore & Michigan Southern R.R. There will be three spans, each of 175 feet long, and one draw span 187 feet in length, to be double track with two trusses and iron stringers. They have also under construction work for the Chicago & Northwestern R., Kansas City, Burlington, & Santa Fe R., North Pennsylvania and Warwick Valley Railways.—*Chicago R. Review.*

—Porter Bell & Co., of Pittsburg, have just shipped another light locomotive to Cuba.

ANSWERS TO CORRESPONDENTS.

LONG BELTS. (G. R. P., Salem, N. J.) An additional advantage to those usually urged, is that the jerking caused by thick joints is better taken up by a long than a short belt.

HARDENING BIT-SHANKS. (A. H., Philadelphia.) They ought to be made of steel; if they are not, case-harden them by bedding in leather scraps and heating. It is cheaper and better to buy new ones of steel.

"BELT" AND "BAND." (G. W. H., New York.) "Band" is British for "belt"—or else "belt" is American for "band." The British term is the more correct of the two. "Straps" or "Strapping" are equivalent expressions.

VARNISHED WALL PAPER. (J. S. W., Pottsville.) If they are varnished well, no fear of poisoning, whether "arsenical green" or not.

SPIRAL GONG. (A. C. P., Chicago,) Make a spiral of heavy flattened wire, and using this as a pattern make a bell-metal casting with a few connections between the coils, filed out afterwards. This will give a clearer and stronger tone than the ordinary steel wire, which is thin and deficient in resonance.

LAYING TILE PAVEMENTS. (W. S. R., Trenton.) Make a level concrete bedding; then pour on this a very thin mixture of Portland cement and water; wet the tiles and lay them on this, using a level; pour in the "paste" between the tiles; keep off for a few days. Plaster-of-Paris makes a good bedding also.

FINE RULED LINES. (L. C. N., Hillsborough.) We know of lines ruled in glass more than 130,000 to the inch. They were done by Nobert.

SAWS GROUND THIN AT BACK. (R. T. W., Wilmington.) This is in continuation of the idea advanced in the "setting and spreading of the teeth," the object being to prevent binding.

COPPER WIRE IN FLANGE JOINTS. (W. E. J., Galt, Canada.) This work appeared in Phila. about 1846; is not a very workmanlike manner, but is commonly supposed to be cheaper than well-faced joints; but the ex-Superintendent of one of our largest works, states that he finds the true full faced flange cheaper than using wire.

FURROWS IN CHIPPING METAL. (S. H., Oswego.) About $\frac{1}{8}$ of an inch apart for wrought iron; $\frac{1}{4}$ inch for cast iron or brass.

PREVENTING PENCIL DRAWINGS FROM RUBBING. (P. R. Q., Richmond.) 1. Ink them in; or 2, wash with skim-milk and water.

[OFFICIAL.]

INDEX OF INVENTIONS,

FOR WHICH

LETTERS PATENT OF THE UNITED STATES WERE GRANTED FOR THE WEEK ENDING

November 20, 1877,

AND EACH BEARING THAT DATE.

Those Marked (r) are Re-issued Patents.

A complete copy of any Patent in the annexed list, including both the specifications and drawings, will be furnished from this office for ONE DOLLAR. In ordering, please state the number and date of the Patent desired, and remit to

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THE

POLYTECHNIC REVIEW.

DEVOTED TO SCIENCE AS APPLIED TO THE USEFUL ARTS.

VOL. IV. PHILADELPHIA, DECEMBER 29, 1877. No. 26.

REMOVING AND MOUNTING THE TWENTY-INCH GUN.

[From the report of Brig. General, S. V. Benét, Chief of Ordnance, to the Hon. Secretary of War, for the year 1876, we extract the following interesting matter. The cuts are kindly loaned us by the U. S. Government, through the courtesy of Gen. Benét and of the Government Printer.]

"This gun, with a 13-inch sea-coast mortar of about 18,000 pounds, a cradle of say about 4,000, with a heavy yellow-pine skidding and a deck-load of lumber, in all about 80 tons, was shipped to me from Fort Monroe on a vessel rated at 94 tons. She nearly foundered in a gale on Chesapeake Bay on her way to the canal at Baltimore, but arrived at this place afloat but leaking badly, with her deck only about eight inches above the water-line, and about four feet below the level of the wharf at high tide. The steam-crane on the wharf had been found by analysis to be insufficiently strong to lift the gun entire; it was consequently simply used as an auxiliary. A 14-inch spar was wedged tightly into the muzzle of the gun and served as a fastening point for the 11-inch hawser by which the gun was raised.*

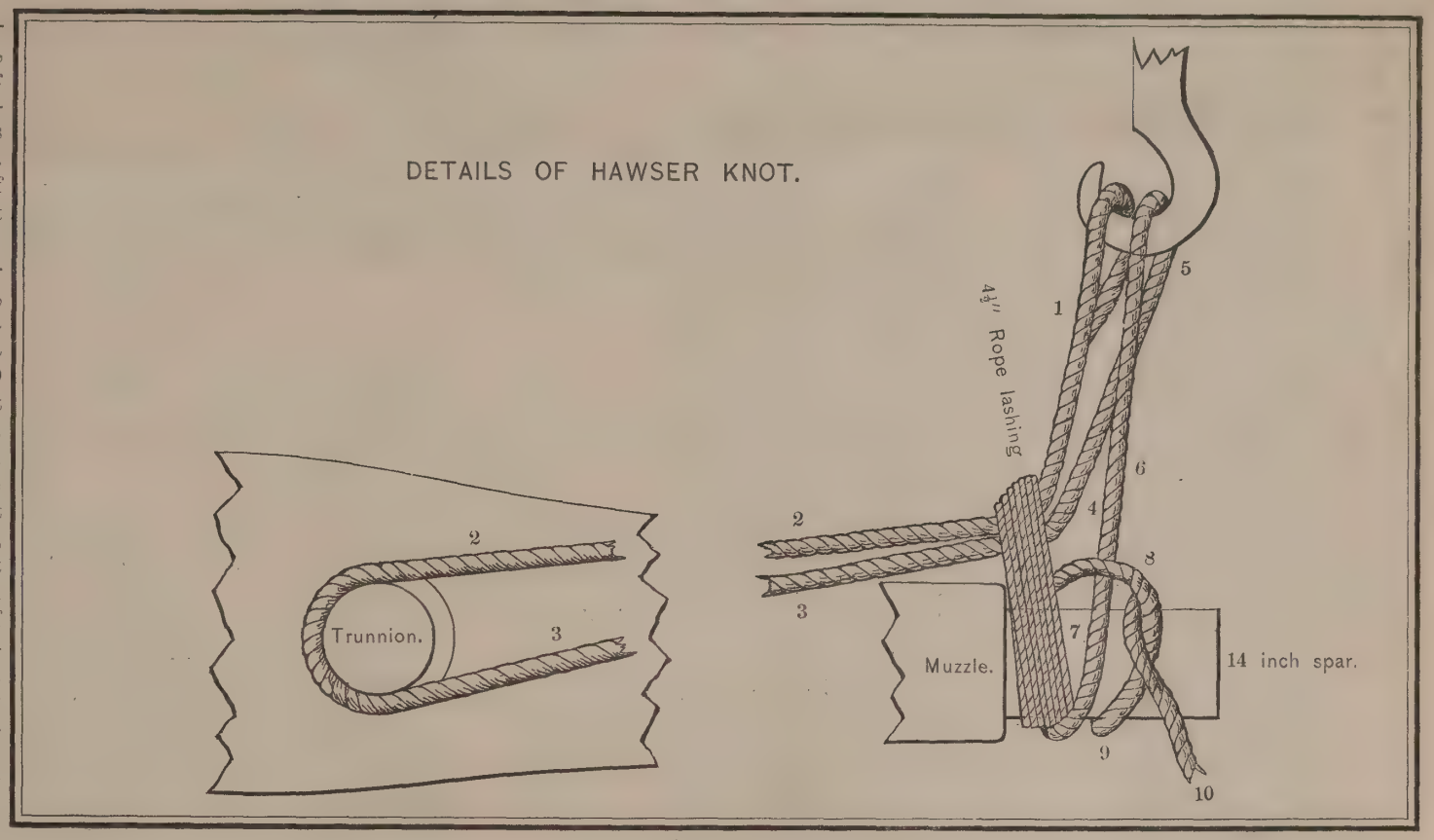


Fig. 1.

The gun having been blocked up about two feet from the cascabel, at four p. m., on Friday, November 5, the crane began to lift. It lifted the muzzle about 15 inches, beside stretching the hawser about eight feet. Blocking was then placed just back of the center gravity of the gun, and the muzzle lowered on this pile as a fulcrum until the breech was high enough to take a fresh pile of blocking beneath it. By this lift the gun was raised about three inches. The position of the three supports was as follows: 1st, five feet from the muzzle; 2d, immediately back of the trunnions; 3d, two feet from the breech. Owing to the position of the third point, the crane was strained about thirteen tons by this lift. Double piles of blocking were used at each bearing-point for safety, so as to limit any accidental fall in raising or lowering the gun to an inch or two at the utmost.

Chocking-quoins were also used to follow up the gun closely in its movements. About fifteen men were used throughout the maneuvers. One of these men, a ship-carpenter, with his adze and crosscut-saw, was particularly valuable. I had also a rigger from the United States navy yard.

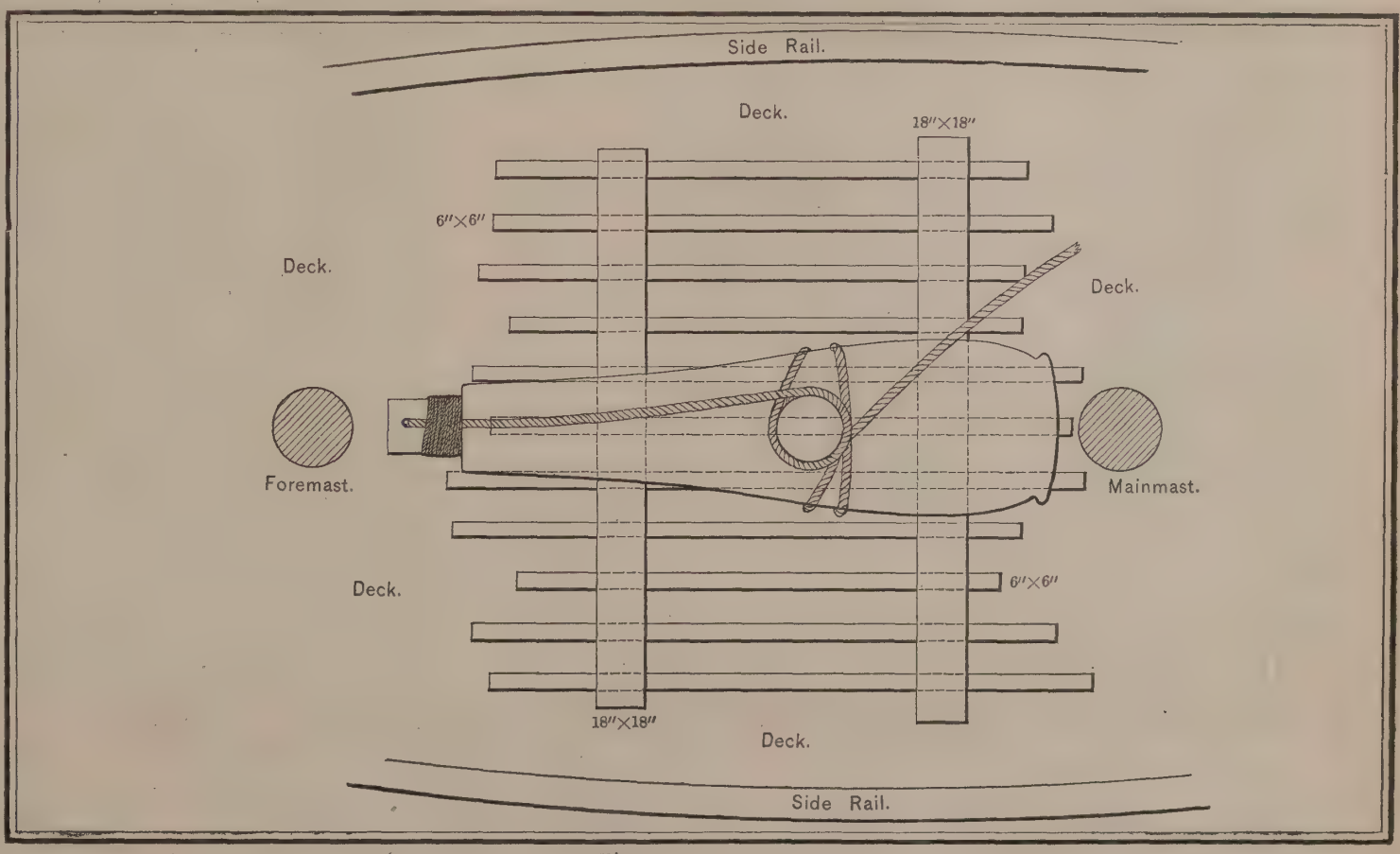


Fig. 2.

The hoists were made as follows:

Heavy 18-inch yellow-pine skidding was then placed from under the gun to the wharf, inclining slightly upward, and the hawser parbuckled around the gun and fastened to the crane. A purchase was taken from the muzzle by a locomotive standing on a neighboring track. The crane began to hoist at 6.44, the gun immediately rolling toward the wharf as the hawser uncoiled. The muzzle was cut meanwhile by the locomotive. At 7.04 p. m. the gun was landed, in 11 hours 6 minutes working-time.

As the vessel was relieved of the weight of the gun it rose, converting the inclined way of skidding into a declivity leading to the wharf. This feature permitted the pile of blocking on deck to be much lower than would otherwise have been necessary. On Sunday the gun was rolled by the crane and locomotive together to a position parallel with the railroad track across which it had been necessarily landed. Toward the latter part of this operation the locomotive was dispensed with, it being found that by placing the crane in a favorable position, taking hold of the muzzle and then topping the boom, the muzzle could be cut almost as well as with the locomotive. At 11.55 a. m. the first lift was made to raise the gun to a sufficient height for loading on the platform-car; nothing could be done, however, until 1.50 p. m., the filling of the dock of coal ashes, street-sweepings, &c., being so soft that whenever the weight was

*The cuts show the position of the gun on the vessel and the arrangement of the lashing.

concentrated on the breech it would keep sinking as fast as the muzzle was raised. Finally, a wide platform was built under the breech, and the effective hoisting began at 1.50p. m.; this was continued till 5 p.m., with the following result:

	p.m.	*Inches.*	
1 .	1.50	3.5	
2 .	2.00	4.0	
3 .	2.10	4.0	
4 .	2.20	4.0	
5 .	2.30	3.5	
6 .	2.50	4.5	
7 .	3.05	3.5	
8 .	3.25	3.6	
9 .	3.40	2.9	
10 .	4.00	2.5	
11 .	4.15	5.5	
12 .	4.20	4.5	Twenty tons
13 .	4.50	3.5	on crane.
15 .	5.00	4.5	
	2.30	54.0	

At 7.15 p. m. the gun was rolled to the car. At 8 o'clock it was on the car, on which it was transported safely the next morning to the exhibition grounds, and unloaded the same day. The advantages of my position in this operation were as follows:

I. The proximity of William C. Allison & Son's wharf and their large car-works, from which I obtained readily supplies of blocking, flat iron bars, heavy tools, men, and notably the use of their steam-crane and railroad-plant. I found the 6-inch oak car-bolsters especially valuable for blocking.

II. The use of an extra heavy flat car procured from the Pennsylvania Railroad Company.

The disadvantages were:

I. The small size of the vessel, its breadth of 23 feet giving only 8 or 9 feet on each side of the bare gun to work in. The gun also occupied all the space between the masts. With the additional weight of the blocking upon her decks used in raising the gun, the danger of breaking them in, or of starting fresh leaks was greatly increased.

II. The captain of the schooner refused to permit hydraulic jacks to be used for fear of breaking in his deck.

III. The gun had to raised so high in order to roll it off upon the dock that the stability of the vessel was considerably endangered.

IV. The captain of the schooner refused to lie alongside the wharf, fearing shoal water; consequently, the gun had to be rolled off from the end of the wharf at right angles to the railroad-track.

V. I was obliged to do so much of the work after dark in the hope of getting the gun on the car by Sunday, the Pennsylvania Railroad wishing to move it to the grounds on that day, for fear of obstruction to the track; otherwise I was liable to car-demurrage.

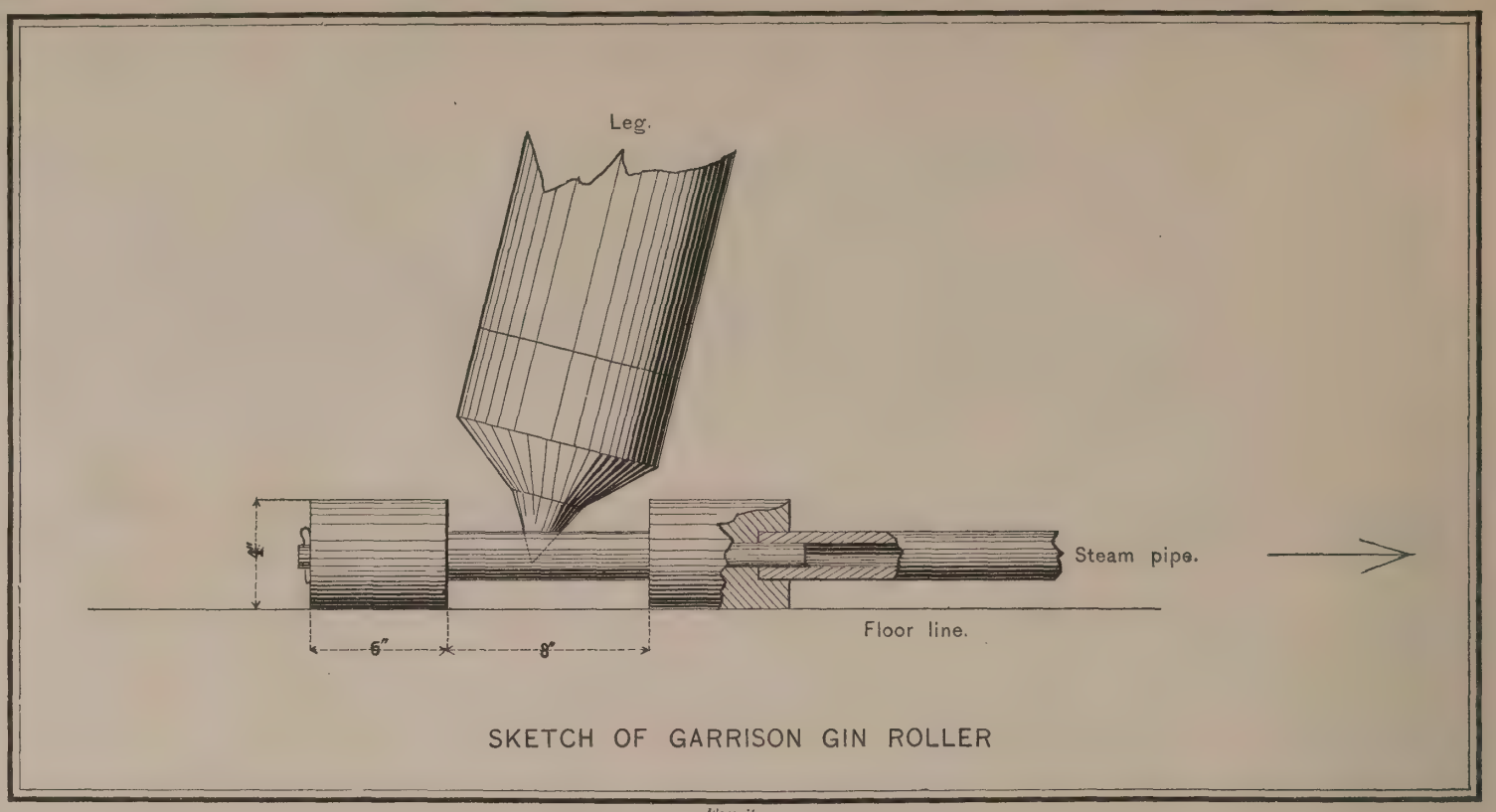
VI. The men were unaccustomed to moving heavy weights and shirked all they could, especially at night.

I was much assisted in this work by Messrs. A. B. Bary, of this place, and R. W. Baylor, now in my employ.

I have ventured to give this full account of the work of unloading the gun in hope that the difficult and somewhat perilous circumstances under which it was performed, and the novelty of some of the processes employed, may be of interest or of possible value.

In mounting the 20-inch gun, the Laidley gun-lift was used, assisted by blocking. The other guns were mounted with blocking only. The light auxiliary shears, provided with the Laidley gun-lift, proved of considerable value in placing in position heavy articles, such as the field-cannon, and the table spoken of, raising the ways of the drop-hammer, &c.

I also used a casemate-gin, mounted on three rollers. This was very useful in picking up heavy pieces, such as lumps of ore, drop-anvils, &c., and moving them to the pedestal of the foundation on which they were to be placed. Two of the rollers on the windlass-legs were joined together by a sleeve of heavy steam-pipe, fitting over the projecting limbs of the axles to prevent the rollers from assuming their natural position at right angles to the line of the leg.†



SKETCH OF GARRISON GIN ROLLER

Fig. 3.

Very respectfully, your obedient servant,

The Chief of Ordnance, U. S. A., Washington, D. C.

HENRY METCALFE,
Lieutenant of Ordnance.

No. of hoist.	Time.	Lift.	Remarks.
	P. M.	*Inches.*	
1	4.00	3.	
2	4.30	3.	
3	4.55	5.	
4	5.15	5.	15 tons on crane.
5	5.32	3.	Took off the mortar with the crane and stopped work.
Saturday, November 6.			
	A. M.		
6	7.30	2.8	
7	8.00	2.25	
8	9.03	4.75	
9	9.31	3.	
10	10.15	2.25	
11	10.40	1.5	
12	11.35	3.25	Crane withdrawn from use by proprietor from 12.30 to 2.30 p. m.
13	2.30	2.25	
14	3.45	3.	It was observed that the muzzle had moved inward about 8 inches from the center line of the vessel, heeling the schooner considerably to port. This was corrected at 3 p. m. by a tackle fastened to side of the vessel, by which the muzzle was cut to a proper position. At 3.15 p. m., the breech having rolled slightly to port, it was rolled back an inch or two with pinch-bars.
15	4.07	7.	
Total, . . .	. . . . .	57	20 tons on crane.

†See cut.

THIMBLE MAKING.

This art, entirely distinct from thimble-rigging, is shown in partial operation at the International Permanent Exhibition, and by the courtesy of the exhibitors, Messrs. Simons Bros. & Co., we visited the extensive manufactory, 611 Sansom St., Phila., and here present an account of the processes involved in the construction of that useful device quaintly called by the Germans a "finger hat."

Our name "thimble" is a corruption of "*thumb-bell*," as the device was first used (as it still is by sailors) on the thumb. It was introduced into England from Holland in 1605, by Jno. Lofting, who manufactured them at Islington. There have been found at Herculaneum, thimbles of bronze, resembling those we use at the present day.

Thimbles are not "spun" like pewter cups, as neither gold, silver, nor hard brass have sufficient flow to permit this.

To make a silver thimble we will say that a trade dollar is taken. (Half dollars are not so pure.) It is rolled out rather longer and thinner; a planchet is cut out by a fly press. A punching press next upsets it (just as making metallic cartridge cases) into a cylindrical cup. As silver is not as ductile as copper, it is then annealed. A second punch works it out into a cup; a second annealing prepares it for a tapered punch, which makes of it a conical cup. Being chucked in a lathe on a steel cone, a cutting wheel on the end of a lever turns off the bur end; a hook tool on a lever turns back the rim, and a groved wheel rounds it. (Very wide rims are hard-soldered on.) A diamond-pointed tool turns off the end and sides and an oiled steel tool polishes the newly turned surface. Next a knurling tool—a narrow rimmed wheel on a suitable handle—indents one ring at a time the concentric rings of pits in the end; the noise produced by this tool being somewhat in a gamut, the outer circle producing quicker vibrations and hence higher tones*. A side knurler with beveled fan and with several rows of

*It might be interesting to our bachelor readers to note here that the "pits" are to prevent the needle head from slipping off the thimble and wounding the fingers. Those who have been in the habit of pressing the needle against the top of a bureau in order to push the point through the waist-band of their unmentionables will find that this arrangement is handy, and entirely obviates having to catch the point between the back teeth and pull it through.

projections produces the side indentations; an inside tool is used, if the thimble be very thin, to smooth out the projections caused by the knurling. These pits could not well (as one might imagine) be stamped in, as this process fails to give the required sharpness of outlines; furthermore it would make the ridges less dense than the bottoms of the hollows, and hence more likely to wear away quickly. A cording wheel makes a rope-like fillet, and other varieties of knurling wheels produce "matt" surface, bead-fillets, &c. Some establishments solder on the tips, but it is claimed that this is not as substantial as striking up from the solid. Other ornamentation than that of the lathe may be given by what is called *chasing*, dull-edged chisels being worked along by a twist of the wrist, so as to produce broken lines, diagonal or otherwise.

After boiling in soap-suds to remove the oil, the thimbles are brushed, and are then ready for the market.

Gold thimbles cannot be punched from the planchet by the same press that "draws" the silver ones, but the blanks are drawn in a hand-fly press. They must be more accurately made than the silver, as they must not vary a weight more than a very few grains to the dozen. There are many sizes of thimbles made, all of them having the same angle of taper or "pitch." All this work is done by piece work. Of course all gold and silver trimmings and cuttings are kept and melted up into ingots. As the silver planchet weighs much more than the finished thimbles, it will be seen that this would otherwise cause quite a percentage of loss.

Pure silver or gold would be too soft to wear well; coin silver ($\frac{9}{10}$ fine) 14 carat gold ($\frac{7}{12}$ gold, $\frac{5}{12}$ silver and copper) is used.

The introduction of the hand-sewing machine does not seem to be injuring the thimble trade, as there are as many seamstresses as ever. G.

ANOTHER SENSIBLE HEATING AND VENTILATING APPARATUS.

The apparatus illustrated in the accompanying engravings, appears to be a very admirable plan of heating and ventilating apartments economically and thoroughly. It is presented to the public as a cheap and effective substitute for the hot air furnace, so generally employed in the American household, being (to quote from the descriptive circular of the manufacturers) specially designed to "save the waste heat in chimneys, and utilize it to warm out-door air for ventilation."

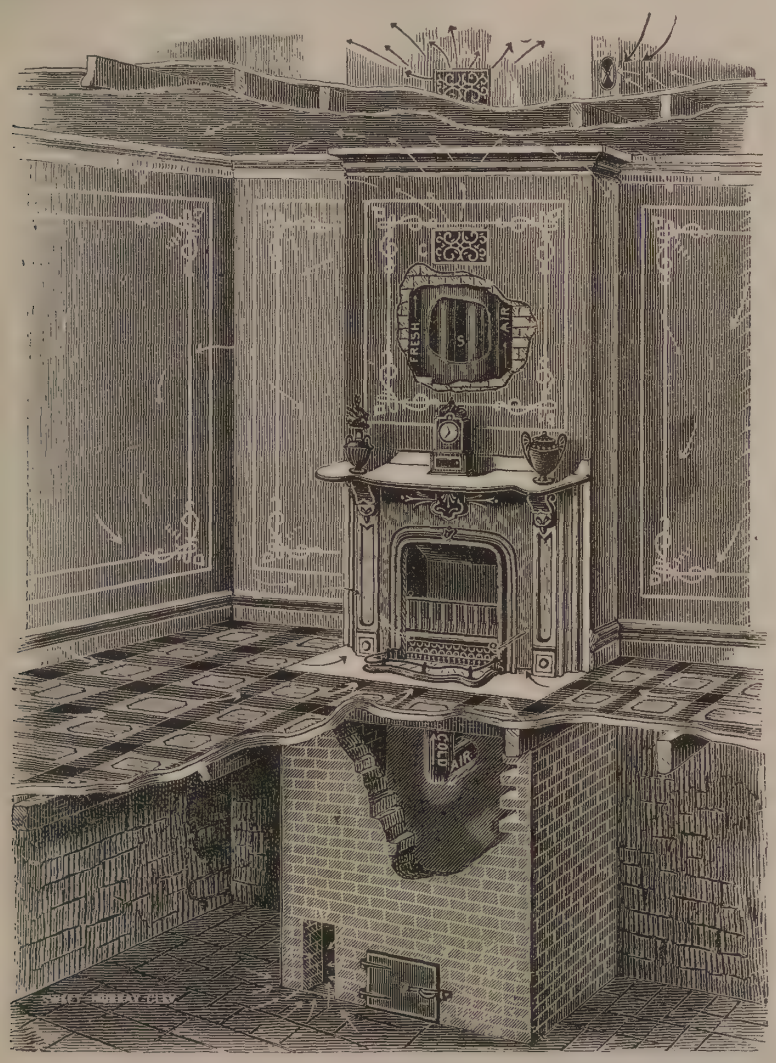


Fig. 1.

Fig. 1 gives a perspective view of the system, in operation, the details of which will be better understood by reference to the succeeding illustration. The peculiar features of the system are shown in Figures 2 and 3, the first of which represents the fire box and its accessories, and the latter, the special modifications of the chimney, which constitute its chief feature of novelty. The fire box *D* (Fig. 2), which holds the grate (forming together the usual low down grate), is furnished at its base with a collar, on which is fitted the duct introducing fresh air. The position of this attachment is better seen in Figure 1. The back of the box is provided with a cast-iron lining, *E*. This lining is corrugated, and perforated with a series of small openings, permitting the entrance of jets of air from the ventilating supply, as will hereafter appear. The purpose of this artifice is two-fold; first to avoid, by increasing the surface of the lining or contact with cold air entering from below, the over-heating and rapid burning out of the fire-box; and second, to provide a smoke consumer in the form of a small but constant air supply above the surface of the fire. *B* represents a cast-iron smoke flue attached to the top of the fire box, and jointed as shown in Figure 3, and extended if desired to the heighth of several stories. By reference to Figure 3, it will be observed that the description of these various details in the chimney is such that a space is left between the brick work of the latter, and the fire box and smoke flue, the brick work being closed in at the termination of the iron smoke pipe. The fresh air, therefore, entering from out doors or from the cellar, between the fire box, forms a passage around the back and sides of the fire box and upward through the smaller air space between the brick flue and the smoke flue, and abstracting heat therefrom in its passage is delivered into the apartments to be warmed at a similar point.

In addition, however, to this body of air warmed by contact with the exterior of the smoke flue throughout its entire length, an ingenious means is employed for multiplying the warming and ventilating capacity of the system, by utilizing the heat of the combustion products passing through the smoke flue. This is accomplished by fitting into the smoke flue two wrought iron pipes (shown in all the figures), by means of which a portion of the air supply is drawn and delivered at another point. It will thus appear that the air supply, after passing over the entire surface of the fire box, abstracts heat both from the exterior and interior of the smoke flue, and may be delivered (as shown in Figure 3,) at different points, thus permitting of the heating of

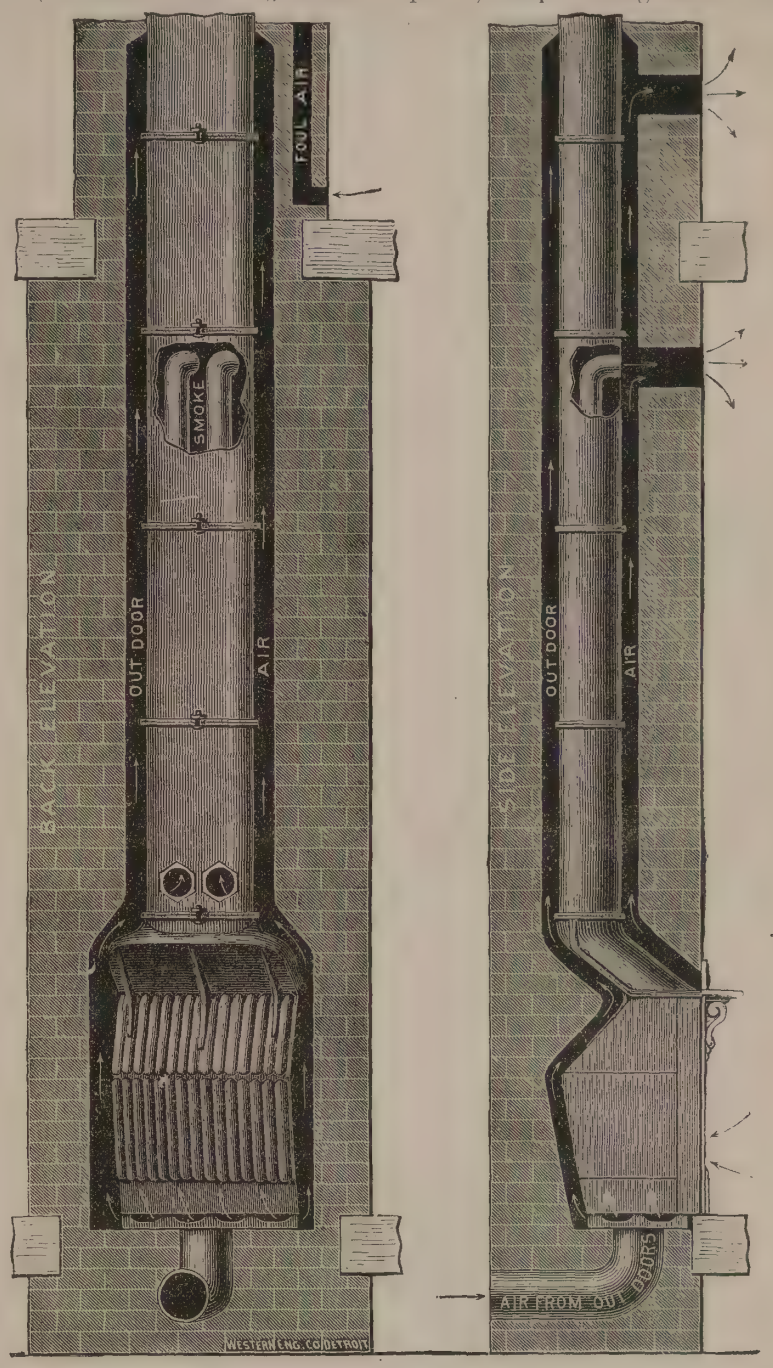


Fig. 2.

several stories. This is well shown in the side elevation of the chimney (Figure 3), and perhaps less clearly in the perspective view (Fig. 1).

Fig. 3.

The warm air thus admitted in a constant current, after making the circuit of the apartment, is withdrawn, either through the grate, in the first floor, or through foul air ducts provided near the floor, or in the upper story.

The device here described, will be seen therefore, to combine the wholesome sanitary features of the open fire-place in respect to heating and ventilating with air warming and distributing qualities of the hot air furnace, with its cumbersomeness and serious first cost. The means adopted to secure the warming and ventilation of several apartments by the interposition of the wrought iron supply pipes is both ingenious in conception, and the abstraction of heat from the heated combustion products by the air current, both outside and inside of the flue, must manifestly effect a very decided economy. The apparatus, when properly put in, is affirmed to be very durable, and to involve but little cost for maintenance. The device appears to be constructed upon rational principles and to possess decided merit.* W.

*This apparatus is known as "Silver's Waste Heat Utilizer and Ventilator," and is manufactured by Lowrie, Shurmer & Allen, 20 to 24 Centre St., Cleveland, Ohio.

WARMING AND VENTILATING.—III.

STEAM-HEATING.

The rapid circulation of steam, even under very slight pressure, and the very large amount of heat it gives out in condensing, are the principal advantages of this mode of heating, which only requires, for the passage of the steam, pipes of small dimensions; but it has, with the forms of apparatus most in use, very grave defects.

Irregularities in the fire affect very sensibly the circulation of steam, and want of attention, especially apt to occur during the night, leads to condensation. When the fire becomes hot again, the steam, which then flows quickly into the pipes, where a partial vacuum has formed, meeting a great deal of condensed water, drives it violently, and the shocks occasionally produce explosions, often cracks and leaks, or at least very frequent, disagreeable noises.

These great objections have generally led to the abandonment of warming by direct steam-circulation, except in factories where the escape-steam from the engines is made use of. In that case it flows constantly through large, exposed pipes, having a slope sufficient to prevent the accumulation of condensed water. But when it is designed to warm dwellings by carrying steam through thin floors, the difficulties increase, and all the unpleasant effects become manifest.

Grouvelle has designed and constructed an arrangement in which the steam does not directly heat the radiators placed in the rooms, but the steam-pipes heat water placed in those radiators. This system, in consequence of the great density of water and its imperfect conductibility of heat, prevents the too sudden checking of the radiation when the flow of steam is diminished or stopped. These radiators have, on top, a little opening, which prevents the temperature of the water from rising above 212°, and the pipes which furnish a passage for the air coming in from the outside, do not allow the temperature of that air to exceed 104° or 113°.

Special arrangements also allow the steam to be carried through the radiators, or through external pipes, so as to moderate the temperature of the room by using only a few of the radiators. But if this plan secures a more regular warmth, it does not prevent trouble from condensation in the pipes passing through the floors, nor from leaks, which are always difficult to discover and to stop. This system is not entirely free from sudden ruptures.

The advantages of steam-heating may be retained, without its principal defects, by arranging the circulating pipes vertically in shafts formed in the thickness of the walls, or specially built for them.

Some of these pipes may be exposed in the form of columns, and be used for warming the hands or the feet.

These arrangements, which agree very well with the condition that the fresh air should enter near the ceiling, secure the immediate return of the condensed water to the boiler, and therefore greatly diminish the effect of leaks, which would be more easily prevented than in the forms usually adopted at present.

Nothing should prevent the adoption, in each ward of a hospital, of an evaporator warmed by steam on Grouvelle's system, in order to promote the comfort of the patients.

It is proper to add, that when the radiators and pipes have a heating-surface of 215 to 258 square feet for 35,316 cubic feet capacity of halls, an elevation of temperature of 29° or 32° may be obtained even in the coldest weather. At Lariboisière Hospital the proportion is 280 square feet, and it is evidently greater than necessary. But there remains against steam-heating the charge of being too readily affected by irregularities in the fire, and particularly by want of attention on the part of the firemen, which during the night may be very much prolonged.

HOT-WATER HEATING-APPARATUS.

This system of warming, which has been known and in use for a long time, with various modifications, is much less apt to cause sudden variations of temperature than the preceding, since hot-water vessels and pipes of equal capacity always contain a much greater number of units of heat than if filled with steam. The great density of water and its steady circulation through the heater long after the fire has become low, maintain a very regular heat in spite of temporary want of attention.

The temperature of the air warmed by this apparatus is always very moderate. It is even difficult to raise it above 100° or 112° with large radiating-surfaces. In this respect this method of heating is very healthful, provided that ample ventilation be maintained in addition.

It is not essential to follow L. Duvoir's plan of placing regulating-receivers in the upper part of the house to which the warm water ascends, in order to secure a sufficiently rapid circulation by the difference in the density of the high-ascending and descending columns.

Provided the pipes be sufficiently large, a small difference in height between the ascending and descending pipes is sufficient to maintain the circulation with even a slight difference of temperature.

The hot-water circulating-pipes may be arranged to warm the air either in the lower portions or in vertical shafts built in or against the walls, through which the outside air passes and becomes warmed by contact with the pipes.

The first arrangement, in which the pipes may be in sight throughout the whole length, and placed in easily accessible places, renders leaks of little consequence, and allows them to be easily found and stopped.

The second, in which hand-hole plates are placed at the top of each section, gives almost the same facility, and allows of the removal of the leakage-water.

Both these plans are more cheaply applied than that which carries the water in the thickness of the floors, and they are free from the somewhat too severe condemnation which has been visited upon the plans of that builder.

In these systems radiators may be entirely dispensed with, or confined to one in each ward for the comfort of the patients.

*[Translated and abridged from the French of Gen. Morin]. From the Smithsonian Reports.

(*To be continued.*)

COFFEE-WASHING AND HULLING MACHINES.*

In the preparation of coffee, the pulp is first taken off. Between this pulp and the husk there is a layer of mucilaginous substance, which must be washed off to obtain a quicker and a better drying of the coffee. Several methods are employed to accomplish this object; with the present machine the work is done very quickly and thoroughly. This machine works in a continuous manner. The coffee, after being pulped, is left in a heap, either by itself or in water, for several hours, to facilitate the decomposition of that gummy substance. The machine then is started, and a small quantity of coffee, mixed with water, is let into the cylinder at one end, and in a few seconds it begins to come out clean at the other end, with the water. Both coffee and water run along a gutter on to a vat covered with a metallic wire or perforated plate, and through the holes the water passes to a convenient outlet, while the coffee remains ready to go to the drying-machine, or to the *patios* or flats. A machine like the drawing, 9 feet long by 20 feet in diameter, will clean 10,000 lbs. of coffee per day.

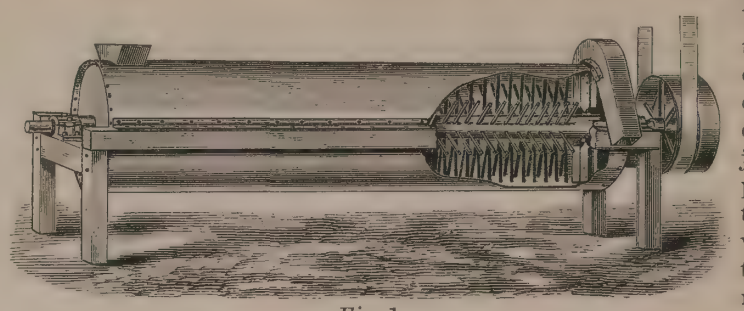


Fig. 1.

The most striking feature of this machine is the novel invention of the construction of the pestle and mortar in which the husk of the coffee is broken and pulverized after the drying process. Both pestles and mortars are provided with a succession of oblique ribs, set at a proper distance from each other, on the surface, so as to form channels, wherein the coffee is pushed up and down, and receives a considerable friction, which speeds the work without injuring the coffee in the least; on the contrary, owing to this increased friction, it acquires a beautiful polish, and loses all that silvery pellicle which gives such an ugly appearance to coffees cleaned by some other processes. Not a single grain of coffee is broken by this machine The pestle is to be so arranged that it can only penetrate or reach within an inch from the bottom of the mortar. The mortars are filled with coffee with the greatest facility, and by opening a valve at the bottom, on the outside, they are emptied in a few seconds, and then refilled. Of course, the pestle of the mortar that is to be emptied is stopped; in the meantime the other pestles continue their work.

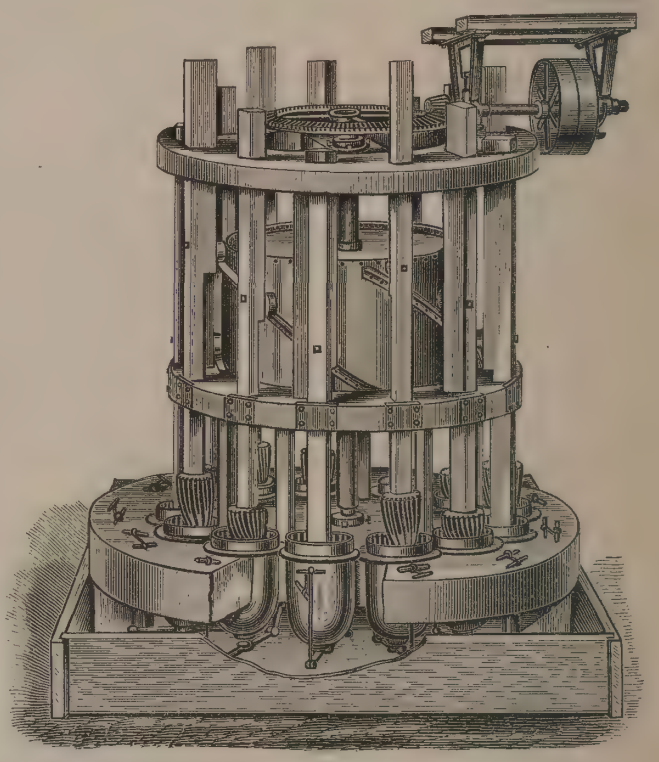


Fig. 2.—*Coffee Hulling and Polishing Machine.*

This is a very plain, strong machine, easily worked. It can be arranged in round or straight batteries. The round arrangement shown in Fig. 2 is composed of thirteen mortars, each of which will clean from 150 to 200 lbs. of coffee per hour.

A hand-power machine is needed for those coffee estates where there is no water or steam power. The machine shown in Fig. 3 is light and easily carried up country over bad roads. This machine is of a continuous system. The coffee is put in the hopper on the top, the machine is started, and a steady stream of coffee goes in and is thrown out all around the circumference, perfectly free from the husk, and falls in the trough that surrounds the plates. Several machines, made on this same principle, have been introduced in former time, but none have been successful; they have lacked the most essential condition to accomplish their object—namely, the adequate elasticity of the rubbing surfaces. This is what the inventor of the present machine has obtained. The rubbing disks can be set at any distance required, and the elasticity of their surfaces is so quick that the machine will not break any grain, even if the revolving plates should be set as close to one another as the smallest grains will require.

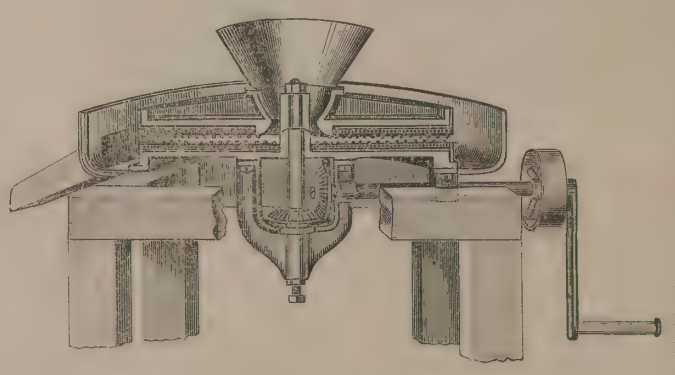


Fig. 3.—*Coffee-Hulling Machine.*

*All the machines above described are patented by Senor Jose Guardiola, Chocola, Guatemala, and are made by Messrs. C. A. Low & Co., 42 Cedar St., N. Y.

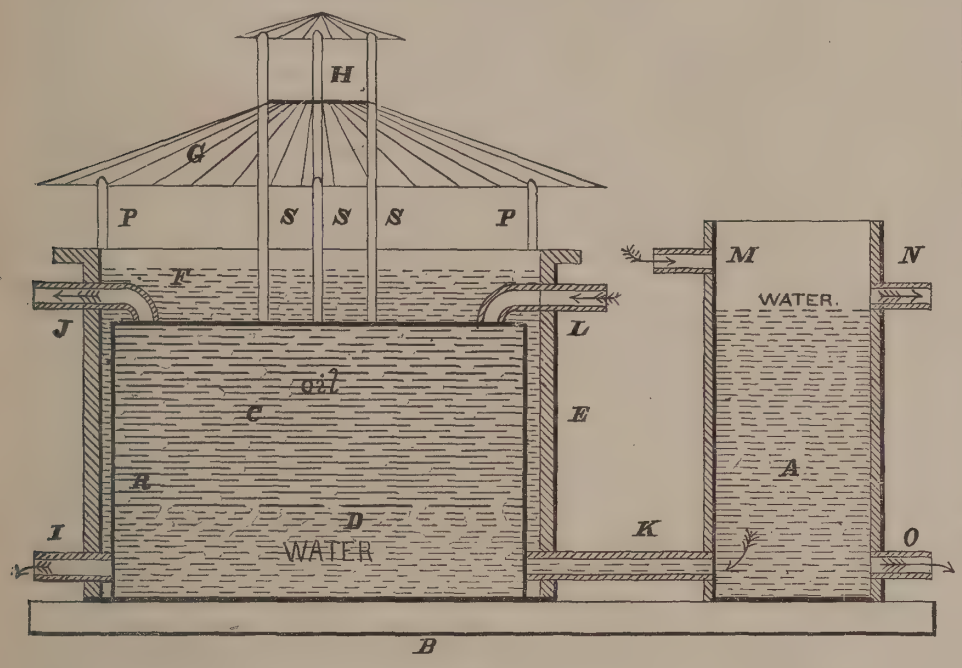
PROTECTION OF OIL TANKS BY A NEW SYSTEM OF CONSTRUCTION.

The destruction, by lightning, of the huge tanks employed in the oil regions of this and adjacent States, is so frequent as to be a very grave source of anxiety both to the oil companies and the fire underwriters. Many theories have been advanced to account for the trouble, and many devices proposed to lessen their liability to destruction; but save where tanks have been constructed with extreme care and intelligently protected by proper rodding, the result of much discussion of the subject, has not been a noticeable decrease in their fire mortality.

In a previous paper, we discussed, in detail, the causes of this special liability of oil tanks to firing by lightning, and indicated, so far as could be done on general principles, the precautions to be observed in constructing and protecting them. It will be unnecessary, therefore, to do more in this place, than to simply refer our readers, who are interested in the subject, to the article in question, our present purpose being to call attention to certain novel modifications in constructing the oil tanks, which have lately been proposed, and which appears to present certain very meritorious features.

The system of construction described and illustrated in what follows, strikes at the root of the difficulty, inasmuch as it proceeds upon the principle of confining the oil in such a manner as to prevent the generation and evolution of oil vapor about the storage tanks. We are disposed to admit that any system of tank construction, that can accomplish this desideratum, simply and directly, will, *cæteris paribus*, afford a decidedly better protection against the peril of destruction by lightning, than those at present in vogue; even with the auxilary aid of the most intelligent plan of rodding.

Herewith we give a description of the system here referred to,* leaving our readers to judge how far it realizes the conditions of the problem.



In the accompanying illustration, *B* represents the foundation which supports the tanks. *R* is the oil tank, closed top and bottom, and placed within a second reservoir, *E*, open above, and designed to be filled with water above the top of tank *R*, to the level *F*. The water of the water tank *E*, therefore surrounds and covers the oil tank *R*. The oil is fed into the oil tank through the passage *L*, and drawn off through *J*, and the tank may be completely drained of its contents by the drain pipe *I*. A smaller water tank *A*, located beside the larger one, communicates with the oil tank by the passage-way *K*; *M* representing a feed pipe for its water supply, *N* an overflow, and *O* a pipe for draining it of its contents.

It is scarcely necessary to note, that all the passage ways shown and referred to are controlled by suitable stopcocks. Above the large water tanks *E*, and secured to it is a metallic roof *G*, supported on short columns *P*. This roof has an opening in its centre, designed for ventilation, and roofed over at *H*. This roof is supported on rods *S*, firmly attached to the main roof *G*, and secured to top of tank *R*.

The operation of the system is as follows: The water tank *A*, so long as kept filled, insures a fully supply of water to the oil tank, so long as the pipes *I* and *O* are kept closed. When oil is drawn off by the pipe *J*, its place is at once supplied by water from tank *A*, which will follow the oil upwards, as long as it continues to be drawn off at *J*, until, when the oil is entirely drawn off, the tank will be filled with water. When, however, the oil is allowed to enter the tank at *L*, it floats upon and gradually forces the water down and back into reservoir *A*, through passage *K*. The surplus of water is discharged through the overflow pipe *N*, and when completed the tank *R* will be filled with oil.

The operations can be carried on simultaneously or alternated, as may be found most convenient, but, in either case, the tank *R* will always be completely filled with liquid, and there will be no opportunity for the generation and evolution of oil vapors, which is the prime element of fire danger, in the ordinary storage system employed. To make assurance doubly sure, however, the outer water reservoir *E*, is provided; by means of which the oil tank is kept completely surrounded and covered with a layer of water, which serves the double purpose of keeping down the temperature of the oil in the tank practically uniform at all seasons, and practically isolating it from the influence of surrounding atmospheric disturbances, of which the lightning is the agent most seriously to be dreaded. To recapitulate, the peculiarities of the system here described reside in the employment of two bodies of water; one to submerge the oil tank, its purpose being to isolate the oil tank from external influences—heat and electricity—and the other to keep the surface of oil flush with the top of the tank, thus confining the oil in a closed and completely filled tank, leaving no air space above the oil surface to permit of the liberation of vapor, and the formation of explosive mixtures of the vapor with air.

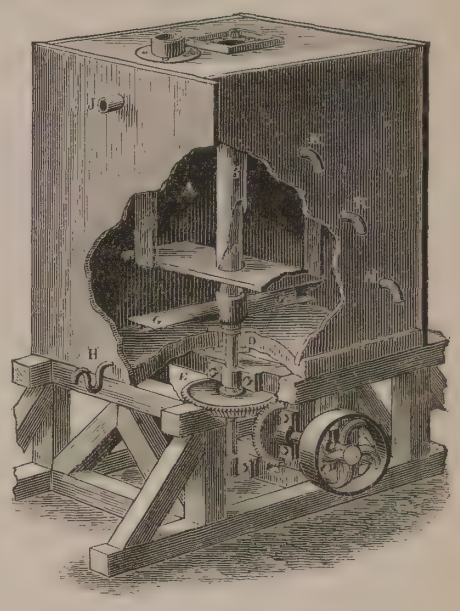
Mr. Shaw in his patent says: "Oil vapors, with the proper mixture of air, will ignite spontaneously at temperatures long before heat becomes visible; in fact, the feeble blue electric spark (invisible in daylight and so low in temperature that it is received on the finger with no more sensation than that produced by a single thread of a spider's web) is competent to ignite the same at every emission of the spark. All masses of material, however feeble their conducting power, serve as a medium for electrical communication; and if any portion be partially insulated, electric sparks more or less powerful are induced, and if any ignitible vapor be in its path, combustion and possible explosion is certain. It is not necessary for a thunderbolt to strike an oil-tank to ignite its contents. Any highly-charged electrical cloud passing over the tank may induce a sufficient spark for the ignition of any combustible vapors, or a thunderbolt may strike the ground miles distant, and the electric discharge be conveyed by means of the piping or other metallic substances leading to or from tank. Large exposures of metallic surfaces offer sure protection from the violent force of a thunderbolt, by reason of the extended metallic surface diffusing the electrical fluid; but there will be feeble sparks emitted in abundance, and one of them is competent to create a disaster by igniting oil vapors; and it is on this theory that the present invention is designed, the entire object being the prevention of generation and accumulation of combustible vapors or gases, and that object is effected by so arranging the oil tank as to keep it always full of liquid, in which case there is no space for vapors or gases to accumulate in."

The system appears to offer decided advantages over the system in vogue, removing the element of danger, and rendering the rodding of tanks, so constructed, unnecessary. We commend it to the notice of oil companies and fire underwriters, as worthy of their consideration.

W.

*Patented by Thomas Shaw, 915 Ridge Avenue, Philadelphia, Pa.

NEW VAPOR CONDENSER.



Herewith is illustrated a vapor condenser, patented by W. H. Long and A. W. Castle, of San José, Cal. It is designed to prevent gold, silver, mercury, and all poisonous gases from escaping with the smoke from reduction, chemical works, &c. In the engraving *A* is a water tank, which has a stationary pipe *B*, another pipe *C* extends through *B* above water level, which is connected to shaft extending through stuffing box *D* and bevel gear *E*. Near the bottom of the tank the pipe *C* is provided with hollow arms *G G*. The operation is stated to be as follows: The pipe *B* being connected with the furnace the fumes will arrive at the arms *G G*; they being revolved there will be produced a partial vacuum at their ends, thus discharging the fumes in the water at the bottom of the tank. The water may be kept cool by allowing a current to enter at *I* and escape at either of the openings *K*, as may be desired. The condenser can be attached to any furnace, flue or smoke stack, and any draft required can be produced.

IMPROVED SASH FASTENER.*

The accompanying illustration represents an improved sash fastener and lock. The tongue *B* is pivoted in lugs situated in part *A* and may be vertically turned up so as not to interfere with the raising or lowering of the sash, being held in position by means of a spring. The clamps or catch *D* is attached to the upper rail of the lower sash. This clamp has a recess which, when the tongue *B* is is turned down comes over said tongue, and prevents it from rising or being moved sideways.

Fig. 1.

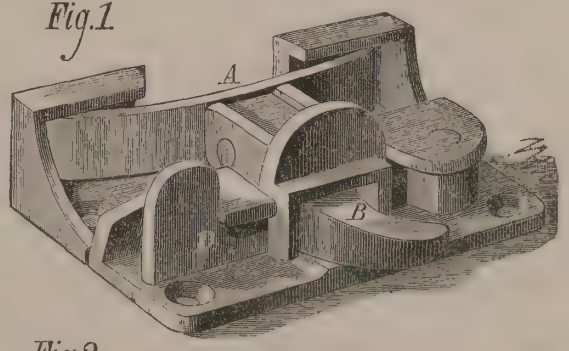
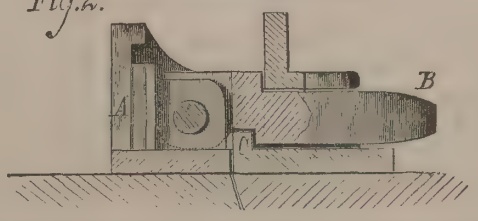


Fig. 2.



*Manufactured by Messrs. Clark & Smith, Chester, Orange Co., N. Y.

PROGRESS IN SCIENCE AND THE ARTS.

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CHEMISTRY, PHYSICS AND TECHNOLOGY.

Comparison of a Coal Furnace and a Siemens' Gas Furnace in the Manufacture of Plate Glass. —The following is a comparison between the working of an ordinary coal furnace and a Siemens' Gas Furnace in the manufacture of plate glass, from data furnished by the Crystal Plate Glass Co., of Crystal City, Missouri:

The coal furnace contained twelve pots, capacity of each 800 pounds=9,600 pounds to a melt, averaging twelve hours to a heat, and consuming 12 tons coal per 24 hours. The breakage of pots was considerable. The flame being unequal, and in consequence non-uniformity in heating. The quality of glass made varied, and from the impure character of the flame the pots needed considerable skimming.

The Siemens' gas furnace contained sixteen pots, capacity of each 1,000 pounds=1,600 to a melt, averaging twelve hours to a heat, and consuming but 4½ tons of coal per 24 hours for the month of September, 1877. Melts have been made in 9½; the quality of glass produced was excellent. Eight melts could easily be made per week if desired. The saving in pots is at least fifty per cent.; the purity of the flame (which contains no scurf or dirt) and the uniformity of the heating accounting for this; also, there is but slight skimming required. The yield per melt is fully thirty per cent. greater than in the coal furnace, and the quality of the glass made is excellent.

The gas furnace was started in August, 1877, and at the present time shows but little wear. The pots are lasting remarkably well, and during September but four of the sixteen were broken.

Zinc as an Anti-Incrustator. —Mr. Lesueur has presented to the French Academy of Sciences a paper on the use of zinc as an anti-incrustator. The fact that zinc possesses valuable properties as a preventive of incrustations in steam boilers was noticed as early as 1861 at Havre. When zinc is put into a boiler supplied with water which deposits thick crusts, it will be found that the scale does not adhere to the iron, but comes off without difficulty, leaving the iron bright and clean. In performing this function the zinc is converted into a white mass, recognizable at a glance as oxide of zinc, which is often found to have retained the lameller structure of the metal Sometimes a core of metallic zinc remains in the centre. It is evident that a slow oxidation of the zinc takes place. A sample taken from the boilers of the Desert mine (Maine-et-Loire) gave the following results:

Water	1.60
Oxide of zinc	87.30
Oxide of iron and alumina	3.80
Carbonate of lime	6.20
Carbonate of magnesia	.50
Sand and clay	1.60

On the other hand, not a trace of zinc was found in the water itself, and but little in the scale, as the following analysis made of material taken from a boiler at Raynaly, Angers, will show:

Carbonate of lime	75.60
Carbonate of magnesia	3.00
Sulphate of lime	9.35
Oxide of iron and zinc	4.20
Chlorides	.40
Sand and clay	8.40

The following is a theoretical explanation of the facts given in the above: The two metals, iron and zinc, surrounded by water at an elevated temperature, generate an electrical current which slowly decomposes the water. The oxygen attacks the most oxidizable body, the zinc and the hydrogen is evolved on the surface of the sheet iron. Thus over its whole surface a weak though continuous evolution of hydrogen takes place, which prevents a solid adherence of the scale to the iron. Experience has shown that for every run of a boiler two lbs. of zinc per horse-power, approximately, are necessary for every hard water; half a pound will be sufficient with ordinary water. Zinc in slabs is preferable to zinc in small pieces.—*Iron Age.*

Plaster Casts that can be Washed.—The prize offered by the Prussian Minister of Commerce and Industry for a method of preparing plaster casts so as to permit of their being washed, has been awarded to Dr. W. Reissig, of Darmstadt. The object was to obtain a surface which should not dissolve in water, and should prevent dust from entering the pores. Dr. Reissig's process consists in converting the sulphate of lime (1) into sulphate of baryta, and caustic or carbonate of lime, and (2) into silicate of lime, by means of silicate of potash. Objects treated in this way are unaffected by hot water or soap, but are still porous and capable of retaining dust, so, in order to render them non-porous, it is necessary to coat them with an alcoholic soap solution, which, on being evaporated, leaves a layer of the soap filling up the pores.—*Telegraphic Journal*, v, 300.

Shipwrecks and Meteorology.—In a paper recently read before the American Philosophical Society, by Professor William Blasius the loss of the naval steamship Huron was ascribed to defective meteorological science. Professor Blasius argues that the instructions supplied to commanders in the navy are misleading in respect to the use of the barometer for storm warnings, and as to the course that should be selected in sailing so as to avoid the worst of a storm. The areas of low barometer which are usually regarded as representing storms, Professor Blasius says, should be considered only as the effects. Two areas of high barometer create an area of low barometer between them; but the storm itself may approach a given position with either falling or rising barometer, according to the kind of storm, the state of its development, and the position of the observer in regard to the storm. These factors in the calculation can be ascertained from observations on the winds and clouds. The rule for selecting a course for the vessel to the left of the path of the centre of a storm—that is, toward the shore for storms travelling from the south up the Atlantic coast—Professor Blasius regards as a mistake, based on erroneous theories of meteorology.—*N. Y. Tribune.*

Telegraphing Without Wires. —Prof. Loomis has late demonstrated the practicability of telegraphing without wires. His method consists of running a wire up to a certain altitude, reaching a particular current of electricity, which, as he asserts, can be found at various heights. No matter what the distance, this same current can be reached by a similar wire, and communications can be had immediately. Professor Loomis has telegraphed to parties eleven miles distant by merely sending up a kite, at each end of the distance, a certain height, attached to which in place of the ordinary string was a fine copper wire. When both kites, though eleven miles distant from each other, touched the same current, communication was had between them both, the messages were sent from one end to the other by means of the ordinary Morse instrument invented by Prof. Loomis.—*Engineering News*, iv, 349.

ENGINEERING—CIVIL AND MECHANICAL.

Tests of Boiler Plates.—A circular from the office of the Supervising Inspector-General, informs supervising and local inspectors of steam vessels that the office has become aware that some manufacturers of boiler iron are stamping iron of their manufacture at much higher tensile strain than such iron will bear when tested by the Richlé testing machine, as provided in Rule 4, Revised, Rules and Regulations, 1877. In consequence of this practice, injury has resulted to boiler manufacturers, who innocently purchased such iron and failed to apply the test until after the completion of the boilers, as recently occurred in two cases in the local districts of New York and Philadelphia. To prevent a practice so unjust and manifestly dangerous, inspectors are directed to obtain samples from the plates of all boilers about to be constructed in their districts, and subject them to an actual test before the boilers are begun, and to represent to boiler manufacturers the importance to themselves of this precaution. Whenever the results of such tests fall below the tensile strength stamped on, the iron inspectors must report such results, at once, to this office, in a statement according entirely with the formula prescribed in Rule 2, on page 13, Revised Rules and Regulations. Inspectors are also directed to carefully ascertain that all samples of boiler plates tested by them have the homogeneousness and toughness required by Section 4430, Revised Statutes, and to be especially careful in that respect where the plates are stamped about fifty thousand pounds tensile strength.—*Phila. Evening Bulletin*, Nov. 28, 1877.

Naval Constructors.—One disadvantage under which the Government has labored in building ships, has been occasioned by its neglect to educate its ship-builders. Instead of preparing its own officers for this purpose by proper professional training, which could have been done at comparatively small cost, it has had to rely mainly upon those who could be withdrawn from the merchant service. The evil is diminishing somewhat, and it is hoped that it will, in course of time, be entirely removed.

The subject is one of the greatest importance, and has received so much attention from the English Government that several of its eminent naval constructors have been knighted for their services. In France none are permitted to enter this corps who have not been pupils in the first class of the polytechnical schools. These, as well as other Governments, have realized the positive necessity of educating these officers at the public expense, and their experience no less than our own has proved that ships of war can not be safely or economically constructed by those who have not been professionally educated for that purpose. An improperly designed ship may compromise the honor of the country. No skill or intrepidity of the officers and men can remedy a serious defect in construction, and when it exists, the total loss of a ship may be the unavoidable consequence.

It is believed that we would soon be supplied with a sufficient number of competent naval constructors, by selecting them from the young men who enter the Naval Academy, and show an aptness or predeliction for mathematfcal and mechanical studies. There are many who enter there whose natural taste lies in this direction, and to whom such studies would be more attractive than those purely nautical. They enter the navy for life, and have to be provided for by the Government. If, therefore, a certain number of cadet midshipmen, willing or desirous to enter the corps of naval constructors, and most proficient in the studies before named, should pursue, for two years at least, a course of study exclusively devoted to the object to be attained, that is to mathematics and their application to mechanics, descriptive geometry, drawing, with kindred subjects connected with their future profession, a corps of naval architects fully competent for planning and constructing the best ships, would, in a few years be supplied. The time now devoted to gunnery, astronomy and other studies necessary to officers who go to sea, could be engaged in developing their mathematical and mechanical talents. The application of mathemetics to the stability of floating bodies, and the other general theoretical principles, can be perfectly taught by the professors of the academy, and this foundation being laid, the intelligent student can readily pursue them in the channels that will gradually open before him. From the academy the cadet should be sent to a Navy Yard, where, under the further tuition of an experienced naval constructor, his progress would be continued. After becoming familiar with the practical operations of the yard, and with the use of materials and tools, he would be prepared to become a constructor.

By means of such a system of professional training as this, is believed that the law which now authorizes the appointment of assistant constructors from the cadets of the naval academy would be attended with practically beneficial results. As it now is, such selections are necessarily made from among these who are educated specially for sea service and steam engineering, whereas the plan suggested requires the method of professional education to have reference to the object to be attained (the construction and building of ships). This important subject is recommended to the consideration of Congress, and is deemed worthy of its serious consideration. These suggestions can be readily elaborated into a practical plan.—*An. Rep. Sec'y. of the Navy.*

Progress of the St. Gothard Tunnel.—The advancement made on the St. Gothard tunnel during the week before last, was 19.4 m. at the Goeschenen, and 29.1 m. at the Airolo end—a progress of about 5.5 m. per day.

At the Goeschenen end, the rock is very hard, while at the Airolo end it is so friable as to necessitate the construction of scaffolding to prevent the caving in of the tunnel.—*Moniteur Ind. Belge*, Nov. 20.

MINING, METALLURGY AND MINERALOGY.

Coal in Colorado.—The various working collieries in the State of Colorado are now yielding together about 8,500 tons of coal per month, which sells at the pit's mouth at $2 to $3 per ton, and by retail in Denver market at $4.50 to $6, according as it is Erie or lignite coal, or Canon, which is semi-bituminous. None of the lignites are sold south of Denver, except along the line of the Kansas Pacific, and Atchison, Topeka and Kansis city, because the Rio Grande Railroad running south of the capital is the proprietor the of Canon City mines and forces its own coal on all the southern towns. The Canon and Trinidad varieties are, however, sold to a limited extent in the northern part of the State, the former principally for furnace use, and the latter for the manufacture of gas, in both of which uses the Erie lignite is not found to be so good. The southern coals of Colorado are found to be an excellent fuel for reverberatories, producing a long flame and a great heat, and there is no doubt that in a few years they will be in common use in the smelting works of the State, either alone or mixed with a portion of Erie lignite. The Trinidad coal produces an excellent coke and a good quality of illuminating gas. At these mines there are a large number of coking ovens in operation, and samples of the product have been treated in the State and in the blast furnaces of Utah with gratifying success.—*Iron Age*

Bismuth Bronze.—A correspondent of the London *Mining Journal* gives the formula for compound bismuth bronze, which he believes will be found of wide usefulness to metal workers. The process is invented by Mr. James Webster. Mr. Webster's object is to produce metallic alloys suitable with or without the addition and admixture of other metals or alloys, as required, for the casting of cannon and other large articles, also ingots, slabs and the like for rolling and for general purposes; and for the production of superior alloys for the manufacture of articles usually made of metals or alloys of metals. For making the hard bismuth bronze or alloy, he takes bismuth, 1 part; lead, 3; zinc, 6; nickel, 15; copper, 25; and antimony, 50 parts; melts them in a suitable pot or crucible and at the same time thoroughly amalgamates them, and then runs the amalgam, alloy or bismuth bronze thus produced into molds of any convenient shape or form for future use, as desired. This bismuth bronze is a hard metallic alloy and may be made into reflectors for mirrors, lamps and the like and into other articles requiring a high degree of hardness or polish; also for axle and shaft bearings, valves and for other similar articles or purposes. It may also be ground into bronze powder and be used for similar purposes to those in which ordinary bronze powder has hitherto been applied.

It will, perhaps, be said that an alloy of this kind would be too costly to come into general use, owing to the high percentage of antimony, and I am inclined to think so myself, except for the purpose of bronze powders, but he also proposes a softer bismuth bronze, which would be as cheap as copper and might be advantageously used for a variety of purposes. The softer kind consists of bismuth, 1 part; lead, 5; zinc, 12; nickel, 30; copper, 52 parts; the amalgamation of the several metals being effected in the same way as in the case of the hard alloy. The latter admixture forms a very tough metallic alloy as is cast into ingots at once, to be afterwards remelted and cast or rolled or otherwise dealt with as required. These alloys will be found to resist oxidation and keep their color better than any other similar alloy hitherto made and can be produced at less cost.—*Mining and Scientific Press*, xxxv, 339.

MISCELLANEOUS.

A New Arctic Expedition.—A whaling steamship, the Vega, has been bought for the Swedish Arctic Expedition, which is to start next July from Gothenburg. The vessel is very strongly built, and can carry coal enough for a cruise of 8,000 miles; she is to be supplied with sufficient provisions to serve for three years. Captain Palander will be in command; less than thirty persons will be on board, in all; three or four will constitute the scientific corps. The King of Sweden, the Government, Oscar Dickson, of Gothenburg, and Mr. Sibariakoff (a Russian), conjointly defray the expenses. The projected voyage will be eastward from Novaya Zemlya, along the Siberian coast, down through Behring Strait; coming back around Asia and via the Suez Canal. This will circumnavigate both Europe and Asia.—*N. Y. Tribune.*

Ships Lost at Sea.—According to the general recapitulation of the maritime disasters, which occurred during 1876, recently published by the *Bureau Veritas*, the following table exhibits the number of vessels lost by the various nationalities:

	Sailing Vessels.	Steam Ships.	Total.
English,	447	70	517
French,	165	7	172
German,	107	5	112
Austrian,	152	15	167
Russian,	26	—	26
Italian,	32	—	32
Spanish,	21	7	28
Hollandish,	58	4	62
Danish,	35	1	36
Norwegian,	135	2	137
Swedish	38	1	39
Belgian,	2	1	3
Portuguese,	11	1	12
Turkish,	2	—	2
Grecian,	15	—	15
Brazilian,	3	—	3
Peruvian,	2	—	2
Republic Argentine,	7	—	7
Unknown,	154	18	172
	1,423	132	1,555

The total of 1,555 comprises 100 *supposed* to be lost, on account of not having been heard from up to the time that the statistics were taken. It is worthy of remark that the number of ships on the seas at the end of 1876 was 582,000, of which 5,771 were propelled by steam.—*La Nature*, v, 350.

Institute of Arts.—The design of this Institute is primarily the furtherance of practical science and the industrial arts, free of all charge. This is intended to be accomplished by free Public Meetings, where important inventions may be presented and described, matters of practical scientific interest discussed, instructive papers read, &c.

Free Public Lectures, affording useful and practical instruction.

Free Classes in drawing and other useful branches.

A free Public Library and Reading Room, supplied with all the principal technical publications.

Free Workshops, for intelligent teaching of handicrafts.

Free Laboratories for practical research.

A free Public Industrial Museum, embracing models, drawings, specimens of raw and manufactured products, &c.

Free Examinations, Tests and Reports upon meritorious inventions.

Free Advice and Pecuniary Aid to worthy inventors.

The details of the plan have been quietly worked out during the past few years, and it is now proposed to put each of them into active operation at the earliest practicable moment. The Institute is not designed as a rival, but rather as a willing coöperator, of other established institutions.

Fuller information may be had by application (enclosing stamp for reply) to the Director, Prof. R. Grimshaw, 119 South Fourth Street, Philadelphia.

French Suicides.—The latest report of the Criminal Administration of France gives curious statistics relative to the suicides committed in France during the year 1874. The figure of 5,617 is given as the number of suicides occurring during that period, and is greater than has ever before been reported. Seventy-nine per cent. (4,433) of these were men, and twenty-one per cent. (1,182) were women. Of 105 suicides the age could not be determined; but of the remainder, 29 were under 16 years of age, 193 between 16 and 21 years, 1,477 between 21 and 40 years, 2,214 between 40 and 60 years, and 1,590 were still older. Thirty-six per cent., or 1,946, of the victims were unmarried; forty-eight per cent., or 2,646, were married; and sixteen per cent., or 881, were widowers. The percentages are 23 for winter, 19 for autumn, 31 for spring and 27 for summer. Thus showing that the percentage for the summer exceeds that of the winter. 2,472 of the suicides preferred strangulation, and 1,514 drowning.

As to the motive which prompted the crime, of 481 nothing is known; 652 were caused by reverses of fortune; 701 by family troubles; 815 were brought to self-destruction by love, jealousy and dissipation; 798 by physical suffering; 489 from various troubles; 1,622 from mental derangement; and 59 were convicted criminals.—*La Nature*, v, 342.

Solid Sulphide of Carbon.—The application of sulphide of carbon to phylloxerous plants has been accomplished with many difficulties, on account of its extreme volatility. M. Cassius has experimented, and succeeded in incorporating the sulphide in gelatine, which is capable of absorbing from 75 to 100 times its volume. M. Dumas presented to the Academy of Sciences small cubes of gelatine impregnated with the sulphide, and is about the action in the vineyards of Béziers.—*La Nature*, v, 351.

MANUFACTURING AND INDUSTRIAK NOTES.

—The Leighton Bridge and Iron Works, at Rochester, have recently received contracts for nine spans of bridge for the Chicago and Northwestern R.R. They have received a contract for a double track bridge over the Merrimac river, at Lawrence, Massachusetts, for the Boston and Lowell road, although their bid ($78,000) was not the lowest, the company preferring their plan.

—The Brooks Locomotive Works, Dunkirk, New York, have sold the Chicago, Milawaukee and St. Paul Railway Company four locomotives—two of 16 by 24 inches, and two 17 by 24 inches.

—The value of railroad cars sent to Chili, during the year ending June 30th, 1876, by American manufacturers was $174,975. This amount will doubtless materially increase from year to year.

—The Edgar Thomson Steel Works have had placed in their works a drop for testing full sections of rails or axles. The drop weighs 1,640 pounds, and has a fall of 47 feet.

—The Zinc Works at Bethlehem have filled large foreign orders during the last war, one order being for 500,000 pounds of spelter, and another of 672,000 pounds. Four metal furnaces of the company, which have not been worked for a year and a half, have just been put in operation. It is expected to start three new furnaces shortly, which will make a total of seven furnaces more than have been working for the past two years.

—The Cambria Iron Works turned out 75,127 tons of Bessemer steel ingots during the year ending October 31.

—The Standard Oil Company will erect a cooper shop in Pittsburg, where seven thousand barrels will be made daily. Oil from the refineries will be conducted to the premises in pipes and barreled.

—The Allentown *Chronicle* says that "there are more iron furnaces in blast at this time than there were at the corresponding period last year in Eastern Pennsylvania, and iron men have a more hopeful outlook."

—The Hampden Watch Company of Springfield, now have about 80 hands at work, and can turn out 360 finished watches a week. The fall trade is expected to be very good.

—An "anti-Coolie" laundry was started in San Jose, but it was a failure and was sold by the Sheriff for $800 more than a mortgage held against the establishment. The machinery and fitting up of the laundry cost $2,600. It could not compete with Chinamen from the start.—*Com. Bulletin.*

—The managers of the Boston, Revere Beach and Lynn Railroad have under consideration the matter of introducing the Eames vacuum brake upon all the cars and engines of the road. The apparatus has been applied upon three cars and one engine, and a trial trip was made which resulted very successfully.

—Hotchkiss & Gaylord, Cleveland, have received orders from several railroads in Canada, to supply bolts for railroad bridges. On an average they manufacture from 25,000 to 30,000 bolts a day.

—The Danforth Locomotive Works, at Paterson, New Jersey, have an order from an Oregon road, and are also building machinery for a cotton factory in Quito, Peru.

—The Cambria Iron Company has obtained the contract for furnishing the rails for the extension of the Castle Shannon narrow-gauge Railroad.

—The first foundry in Pittsburgh was erected in 1803, on the site now occupied by the post-office. Its products at first were pots, kettles, and other domestic utensils, but in a few years it was called upon to make cannon-balls for the government, and in 1811–12 the first cannon made west of the Allegheny mountains was cast at this foundry, the establishment being thereafter kept busy furnishing cannon and shot till the close of the war, in 1814. The first water-pipe and the first rolls were also made at this foundry; and it was in this pioneer establishment that James Harley, a moulder, discovered the method of making chill rolls.—*Am. Manuf.*

—The manufacturing interests of East St. Louis are looking up. About five weeks ago much anxiety was caused by the closing of the car department of the Missouri Car Works and Foundry, throwing some 300 men out of employment, but the company have now received a large contract for cars, and the work will be put in motion within two weeks at the latest, and a force of 400 additional men will be employed. The company has been running in the foundry department right along, turning out sixty wheels, and making between six and seven tons of castings a day. The foundry employs 150 men, and the reemployment of 400 additional hands will liven things up wonderfully. The old East St. Louis Rail Mill, owned by John Allerby, of St. Louis, which has been idle for a long while, and which was used during the strike as a barracks by the regular army, has been thoroughly repaired, a watchman set over it, and although the managers are not able to speak definitely, still it can safely be said, it will before very long glare and smoke as of old.—*Com. Bulletin.*

EDITORIAL CORRESPONDENCE.

On Nails.

EDITORS POLYTECHNIC REVIEW:

I was quite interested in your article on "Nails", published in last week's REVIEW, for reasons which will appear hereafter.

Pointed brads, the same in outline as your illustration, were used as long ago, as 1850, but they were worthless, for as they were cut without turning the plate, and as a consequence were diamond or lozenge shaped in cross section, they would twist or turn cornerwise in the mould in spite of every precaution.

At the Paris Exhibition an American machine was exhibited cutting the same form of brads, ten at a time, working up the whole sheet, and of course without turning it. While the tools were kept sharp this machine made fair work; still the brads had a twisting tendency.

In a paper you published of mine last August, mention was made of a brad machine which I built in England, which made brads of this form, but being cut with a punch and die which produced the same result as turning the plate, they were square, and the best driving and holding cut nails I ever saw, though for holding, I question if anything equals the French wire nails owing to the parallel fit, but they are not so good a distinction.

I infer from your article that Messrs. Morris, Wheeler & Co., of Philadelphia, are making these chisel pointed nails and brads, (or the machinery to make them with); and if they are true, so as not to twist or glance off in driving, they deserve success, better success than they are liable to meet with, I fear, for it is such a hard thing to introduce a right thing when a wrong one has been so long in vogue.

To your remark, "a more unworkmanlike job than the best driven of our common cut nails it would be difficult to imagine," I would say that I know of but one, and that is the tang of a common file.

I do not know that Messrs. Morris, Wheeler & Co., will think this voluntary endorsement of mine much of a compliment, but if I could get them, or any one else, to grind down the tang of a file to the form shown in No. 2 of "Tools and Their Uses," and say it is right (as I know they would if they tried it once), it would be very gratifying to me, for the square ended nail and the blunt tapered file tang are parallel cases—parallel in absurdity.

Yours, etc.,

Cornell University. JOHN E. SWEET.

ANSWERS TO CORRESPONDENTS.

CAST GEARS. (J. T. B., Phila.) If the patterns are carelessly made and used, shrinkage neglected, the draft sides meshed together, &c., you can hardly expect much of cast gears, especially if the teeth were laid out by "rule of thumb."

ALUMINUM BRONZE BEARINGS. (C. C. C.) There was an aluminum bronze bearing in Carhart & Needham's melodeon factory, N. Y., keeping cool under 7,000 revolutions per minute. The composition is 90 copper, 10 alumina.

PRESURE ON A SLIDE-VALVE. (C. J. R.) Some of our correspondents may wish to open up this much-mooted question, but we decline to get started on the controversy which would inevitably result upon the appearance of an article on this subject, in our columns, by any one.

CAN OIL ENTER A STEAM-CHEST AGAINST STEAM PRESSURE? (A. O) Yes, it might, if the oil-cup fed in right by the side of a steam port, so that the inflowing current of steam should play *across* the oil orifice, thus making a vacuum. We enter our protest against oil in steam-chests and cylinders, on every opportunity. Animal oil is *sure* to make the metal parts "worm-eaten," and there is no need for oil, if the engine is properly constructed and run.

THEORY OF BOILER EXPLOSIONS. (H. F. S.) There is not much theory required, and very little provable, except that the boilers are not strong enough, or are carelessly used, or both. The fine-cut theories about hydrogen, electricity, spheroidal state, etc., simply *will not work* on an experimental boiler, if you *try* to blow one up.

[OFFICIAL.]

INDEX OF INVENTIONS,

FOR WHICH

LETTERS PATENT OF THE UNITED STATES WERE GRANTED FOR THE WEEK ENDING

November 27, 1877,

AND EACH BEARING THAT DATE.

Those Marked (r) are Re-issued Patents.

A complete copy of any Patent in the annexed list, including both the specifications and drawings, will be furnished from this office for ONE DOLLAR. In ordering, please state the number and date of the Patent desired, and remit to

WAHL & GRIMSHAW, Publishers,
119 *South Fourth Street, Philadelphia.*

	Class No.	No. of Patent
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Bale tie, W. Sylvester	7	197.570
Bale tie, cotton, W. Clark	7	197.602
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